STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

CALIFORNIA DIVISION OF HIGHWAYS

REPORT ON TESTS MADE BY THE

MATERIALS AND RESEARCH DEPARTMENT

In connection with a cooperative study to determine the relative efficiency of various expansion joint and weakened plane load transfer devices.

X-Mer-4-A-Merced City Southerly--W.O. 010T7

1938 - 1939

December, 1939

Research No. .00160

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SUMMARY.

The tests described herein were part of a cooperative study by Headquarters Surveys & Plans, Construction and Materials and Research Departments, and District X of the California Division of Highways, to determine the relative efficiency of various expansion joint and weakened plane load transfer devices.

The work to be done was outlined in considerable detail in a memorandum by Fred Grumm, Engineer Surveys and Plans, dated March 1, 1938.

Subsequent to that date, the test section, including the various load transfer devices, test recording instruments, etc., was completed and tests conducted in December, 1938 and July, 1939.

A preliminary report on the laboratory work was submitted, under date of January 6, 1939.

This report brings up to date the data included in the January 6th report, as well as other test data secured before and since that date.

The description of the job, as a whole, including a detailed description of each load transfer device is being written by the Surveys and Plans Department and does not require repetition here.

This report is, therefore, confined to a description of the work done and data recorded by representatives of the Materials and Research Department.

As stated, the first measurements were made during November and December, 1938, shortly after the pavement was completed.

Very little overall or differential deflections of the concrete slabs at any of the joints was noted at that time; primarily because of an excellent subgrade which afforded ample support under a 16060 lbs. rear axle load and the fact that, due probably to uniformity of temperature between top and bottom of the slab, there was little if any warp or upward curl of the pavement at the joints. The maximum deflection noted at this time was less than two-hundredths (0.02) of an inch and, therefore, the maximum differential movements between two adjoining slabs, which occured at the joint with no load transfer device was less than two- hundredths of an inch (Table 1).

Deflections of a somewhat higher order were obtained at the subsequent test in July, 1939, due primarily, to uplift of the ends of the pavement slabs occasioned by temperature differentials between the top and bottom of the slabs. Even so, however, the curl was not great and, therefore, the deflections were not high. The maximum movement in July, 1939, which occurred at the time of maximum curling, was not over 0.065" for the joint without load transfer (Table 2 and Fig. 7) and the minimum deflection for the same type joint was not over 0.007" at time of minimum upward curl. As was to be expected, the maximum curl upwards, was early in the morning when the pavement surface temperature was at a minimum and the minimum curl later in the day after the surface had heated and expanded under the sun's rays.

However, even though the total deflections were of a relatively low order, the test equipment was so sensitive as to detect movements of 0.001" and it was, therefore, possible to measure, with considerable accuracy, the differential deflections and consequent relative efficiency of the several load transfer devices, as will be noted in the tables and figures.

The day and night readings are shown in Fig. 9 (Table 6). Special attention is called to joint 4 (thickened transverse edge without dowels or other load transfer devices). In all cases, joint 4 showed the greatest deflections, but even at night, the time of greatest curl, the deflections averaged only 0.05". In the day time the average deflection at the same joint was less than 0.01".

GENERAL DESCRIPTION OF TEST SECTION AND EQUIPMENT

The test section was constructed in the right (east) traffic lane, of the four-lane highway between Stations 668+20 and 687+60, under Contract 010TC5, Road X-Mer-4-A. Eleven types of load transfer devices were installed in the expansion joints in combination with seven types of joint fillers. Five contraction joints were also included in the test.

The construction on this portion of the project consists of an 11' wide Class "B" P.C.C. pavement, having a thickened free (outside) edge, the section being 0.55' -0.55' 0.75'. The expansion joints were placed at 60' intervals with contraction joints on intermediate 20' spacing.

The pavement was constructed over a 1.0' base of selected imported borrow, below which was a layer of pit run imported borrow and natural soil, largely of poor character.

INSTALLATION OF APPARATUS.

Pipe Coupling Units.

Standard 3" pipe couplings, with the necessary length nipple for the thickness of P.C.C. pavement were cast in the pavement during construction. The coupling units (closed with a standard 3" recessed pipe plug) were held in place by chairs (Fig. 4), while the concrete was being placed. They were installed about 1-1/2" below the header grade to allow the tamping machine and finisher to pass over during construction, after which they were pulled up until the recessed plugs were flush with the surface and the pavement finished by hand.

The pipe coupling units provided openings through the pavement for the installation and operation of the measuring equipment and also for obtaining samples of the subgrade for moisture determinations. Fig. 1 shows the location of the coupling units with respect to the joint. Couplings, A, B, C, D, E, F, G and H, are for vertical deflection measurements and X, Y and Z are for obtaining subgrade moisture content samples.

Reference Rods.

A reference rod was driven into the ground beneath couplings A, B, C, D, E, F, G and H . A hole was first made by a No. 1 soil sampler to solid material, after which a 1" thin wall electric conduit, for a casing, was pushed to the bottom of the hole. A 1/2" pipe, topped with 1/2 X 3/4" bushing and a 3/4" brass cap, was then driven through the casing between 6" and 1' into solid material with the top extending about 2" up into the pipe couplings (Fig. 2). The brass cap was then drilled and tapped to fit a 1/4"-20 thread fitting on the electric gauges.

Thermo Couples.

Thermo couples were installed to measure the temperature of the top, bottom and center of the pavement slab. The top and bottom thermo couples were placed about 1" from the respective faces.

TESTING EQUIPMENT.

Change in Elevation.

The seasonal changes in elevation of the concrete were measured with an ames dial mounted in a jig. The measurements being taken between the coupling cast in the pavement and the reference rods. The base readings were taken at the time the original deflection readings were made in December, 1938.

Change in Opening Across Joints.

The change in length of the pavement, due to expansion and contraction, was determined by measuring the distance between fixed points in the pipe couplings on each side of the joints. For this purpose a 3" pipe plug with a stud mounted in its center was screwed into the coupling a definite distance (Fig. 3). The distance between the studs on each side of the joint was then measured with a standard micrometer screw mounted on an adjustable frame. The initial or base readings were taken at the time the original deflection readings were made in December, 1938.

The change in opening across the joints in the variable expansion joint spacing section was determined by measuring the distance between brass plugs cast flush with the surface of the pavement on each side of the joint. Studs were then screwed into the brass plugs and the change in distance measured with an ames dial mounted in a frame. The initial or base readings on these joints were made the day following the placing of the concrete.

Pavement Deflections.

The vertical pavement deflections were measured with special electric gauge equipment. A schematic diagram of the gauge is shown in Fig. 2. This equipment consists essentially of an electric gauge head, which is mounted in the pipe couplings cast into the pavement and coupled with electric wires to the control and recording equipment. The electric gauge head consists of two parts. One part a coil of wire mounted in a brass frame fitted with standard 3" pipe threads, and having an opening in the center. The other part is a small iron plunger mounted on a threaded brass rod which passes through the center of the coil and is screwed into the top of the reference rod. The deflection of the pavement (to which the coil is attached) with respect to the iron plunger (attached to the reference rod) is measured by the recording equipment.

The recording equipment is a standard oscillograph, constructed so that any relative movement of the electric gauge parts is converted into movement of a light beam. This light beam moves in a horizontal plane. A photographic film, mounted in a variable speed camera, passes this moving light beam and provides a continuous picture of its location. The electric gauge equipment is capable of responding to measurements lasting for time intervals of one-thousandth of a second, or longer. The oscillograph is constructed so that a calibrated viewing screen may be used instead of the camera for determining the position of the light beams and for calibration of the electric gauges. Provision is made for recording three separate units on one film. A 50-cycle timing line is also recorded on the film for timing purposes.

The exact time at which the truck wheel passes over the joint is determined by a photo electric cell. A beam of light, falling on the cell, is broken by the truck tire as it passes over the joint, and by suitable connections to the recording equipment a displacement of the timing line is caused.

The most sensitive setting of the electric gauge was used for these tests--a relative movement of 0.080" between the electric gauge parts causing approximately a 2" movement of the light beam in the recording apparatus. The amplification between the gauge heads and recording equipment is accomplished, in the control equipment, by electrical means.

The special electric gauge equipment consists of the following units.

1. General Electric Gauge Heads.
2. General Electric Balancing Units.
3. General Electric Power Units.
4. General Electric Power Supply Unit.
5. General Electric P. M. Oscillograph
6. General Electric Photo-electric Relay and Light Source.
7. General Radio 50-Cycle Tuning Fork.
8. Connecting Wires, Batteries and Gasoline Driven Generator.

1. Electric Gauge Heads.

Fig. 10 is a photograph of one of the electric gauge heads. Fig. 17 shows a cross section of the gauge head. It is designed to mount in a standard 3 inch pipe coupling. The pipe coupling to be cast in the pavement slab at the location at which it is desired to measure the vertical movement.

The gauge head consists essentially of a brass mounting unit containing a special iron-clad solenoid coil with a hole through its center and short iron plunger mounted on a threaded brass rod. The solenoid is rigidly attached to the pavement through its mounting unit and a 3 inch pipe coupling, and the plunger is attached to the reference rod with a threaded brass rod. Relative motion of the solenoid coil (attached to the pavement) and iron plunger (attached to the reference rod) produces a deflection of the oscillograph.

2. Balancing Unit.

An iron-clad coil and iron plunger, having the same electrical characteristics as the gauge head, are mounted as a unit. Provision is made for adjusting the position of the iron plunger and locking it in position. Six individual balancing units are mounted in one case as shown in Fig. 11.

3. Power Unit.

The power unit contains the electric circuit for the gauges. This equipment, as shown by the schematic wiring diagram Fig. 12, contains the differentail transformer (ratio coils) of the wheatstone bridge circuit, sensitivity control, filter system, rectifier, switches and terminals for connecting the various parts of the circuit. Six individual balancing units are mounted in one case, as shown in Fig. 11.

The cases containing the six individual balancing units and the six individual power units are of the same length so they may be mounted side by side and interconnected by means of links.

4. Power Supply Unit.

The power supply unit (Fig. 13) consists of a 12-volt direct current, 2000-cycle, 110-volt alternating current motor generator, set with an output transformer to reduce the output voltage to 30-volts. The panel board contains rheostats for controlling the output frequency and voltage, and meters for measuring the output frequency and voltage. A meter is also included to measure the direct current input voltage.

The output of the power supply unit is held at exactly 2000-cycles and 30-volts for all calibrations and measurements with the electric gauges.

5. P.M. 14 Oscillograph.

The oscillograph, as shown by Fig. 14, is a standard magnetic type fitted with four supersensitive galvanometers and a continuous-drive film holder.

The supersensitive galvanometers are of the light beam type, having a frequency response up to 500-cycles per second, without a correction factor, and a current sensitivity of approximately 0.17 milleamperes per millimeter deflection of the light beam as recorded on the oscillograph film. The galvanometers are also fitted with stationary adjustable zero mirrors. These mirrors record as straight lines on the oscillograph film for use as reference or zero lines.

The optical system is constructed so that a beam of light from a 50 C.P. automobile lamp is reflected by a mirror, through an adjustable orifice, to the mirror on the galvanometer, then back to a cylindrical lens which focuses the beam as a spot at the front of the oscillograph. The front of the oscillograph is designed for mounting either a ground glass calibrating screen or a continuous-drive film holder. The continuous-drive film holder is constructed to take films up to 6" in width and 15' long. The film is driven at a uniform speed, by means of an adjustable speed electric motor, past the orifice in the camera and records a continuous picture of the position of the light beams as shown in Fig. 5.

The characteristics of the electric gauge and recording equipment are such that transient movements lasting up to 0.001 second may be accurately measured.

6. Photo-electric Relay.

The photo-electric relay as shown by Fig. 15, consists essentially of photo-electric cell, condensing lens, and a vacuum tube amplifier mounted in a metal container. Leads are brought out to facilitate connecting with the oscillograph and batteries. The output of the vacuum tube amplifier is connected directly to one of the oscillograph galvanometers. The batteries furnish power to operate the photo-electric cell and vacuum tube amplifier.

7. 50-Cycle Tuning Fork.

A general radio, 50-cycle, electrically maintained tuning fork is used to record a 50-cycle time line on the oscillograph film. The tuning fork is equipped with a microphone button and an impedance matching transformer for connecting directly to a galvanometer in the oscillograph.

In operation, the tuning fork and photo-electric relay are connected in parallel to the same galvanometer. The instant that the truck wheel cuts off the light to the photo-electric cell is then recorded as a jump in the time line. The truck wheel is wide enough to interrupt the light for a few cycles of the timing line, so the exact time when the truck wheel is at the indicated location is recorded as one-half way between the edges of the jump in the timing line as shown by Fig. 5.

8. Batteries and a Gasoline Driven Generator.

One 12-volt and two 6-volt storage batteries are required to operate the equipment. The 12-volt battery supplies the input power for operating the power supply unit and the 12-volt 50 C.P. lamp in the oscillograph. One 6-volt battery supplies power for operating the motor driving the continuous-drive film holder, and the other one is used for supplying the 6-volt 50 C.P. light used in connecting with the photo-electric relay.

The combined power drawn from the 12-volt battery is about 15 amperes. A gasoline driven generator is floated across the battery to supply most of this current and keep the batteries charged. It is also used to furnish lights for night operations.

The 6-volt batteries are used only for short intervals of time during actual recording so require only infrequent charging.

Dry batteries are supplied for the 50-cycle tuning fork circuit and for the photo-electric relay.

Calibration.

The component parts of the electric gauge circuit are connected as shown in Fig. 12. The gauge head is connected to the power unit by the length of wire that is to be used in actual field measurements. The gauge head is mounted in the calibrating device as shown in Fig. 18.

A typical curve of oscillograph deflection plotted against gauge deflection is shown in Fig. 16. The right hand slope of this curve is a straight line over quite a range of gauge deflection, so the deflection of the gauge is controlled to operate over this section of the curve. The slope of the curve is determined by the setting of the sensitivity control on the power unit panel.

The position of the iron plunger in the gauge head is set at a predetermined point by means of a depth gauge. This position will cause the gauge to operate over the desired portion of the calibration curve. The position of the balancing unit is then obtained by switching on the power and adjusting its iron plunger for the desired deflection of the oscillograph at zero gauge reading. The adjustment on the balancing unit is then locked in position. The calibrating device is then moved by increments and a record made of the corresponding oscillograph deflections.

Each individual gauge unit and its corresponding balancing unit was calibrated with a specific oscillograph galvanometer. The oscillograph contains four galvanometers. Three galvanometers were used for recording three electric gauge units at one time and the other galvanometer was used for recording the time line and output of the photo-electric relay.

Three of the electric gauge heads and balacing units were calibrated for the most sensitive setting of the equipment. This setting produced approximately a two-inch oscillograph deflection for 0.080" deflection of the electric gauge. The other three electric gauge heads and balancing equipment were calibrated at a less sensitive setting of the equipment. This setting produced approximately a 2" oscillograph deflection for 0.2" deflection of the electric gauge. These calibrations remain constant unless the sensitivity control or the position of the iron plunger in the balancing unit is changed.

With two ranges available, it is possible to secure large deflections of the oscillograph for small deflections of the pavement and still be able to measure greater pavement deflections when they occur. This allows the measurement of large or small deflections without recalibrating the gauges in the field.

TESTING PROCEDURE.

Moisture Content of Subgrade.

The moisture content samples of the subgrade were secured at each location from 0-8" and 14-26" below the bottom surface of the pavement slab. The 0-8" depth represents the moisture content just below the pavement slab in the selected imported borrow. The 14" to 26" depth represents the moisture content in the material underlying the selected imported borrow.

The samples for moisture content reported for November, 1938, were secured from the E location at the time the reference rods were installed. The samples for moisture content reported for June, 1939, were secured through the couplings labelled X, Y and Z.

Vertical Deflections.

Vertical deflection measurements of the pavement were made by placing the electric gauges in the couplings provided in the pavement for this purpose, and adjusting them to zero position with no load on the pavement. The photo-electric cell and light source were set up so that the light beam was focused along the joint under test.

The static deflections were taken on selected joints. These deflections were taken, using the electric gauge equipment. The rear axle of the truck was spotted approximately 8" north of the joint with the truck centered along the slab. The deflection was then determined from the position of the light beam on the viewing screen of the oscillograph. The truck was then spotted with the rear wheels approximately 8" south of the joint and the position of the light beams recorded.

The dynamic deflections were then taken with the camera on the oscillograph and the truck driven over the joint at 15 miles per hour, the movement being recorded on the film. The readings were then repeated for a truck speed of 30 miles per hour. The truck was driven so that it was as near the center of the lane as possible for all readings and in the direction of normal traffic flow. This proceedure was reapeated for the points around joints as shown in the tabulations.

Change in Opening Across Joints and Change in Elevation.

Readings were then taken of the opening across the joints, and the position of the reference rod with respect to the pavement. These readings when compared with the readings secured in December, 1938, indicate any changes taking place subsequent to the original deflection readings.

Thermo Couples.

The temperature of the paving slab was determined from the thermo couple readings.

The water truck used for the tests made December, 1938, was a Mack (C.H.C. 3687). The front wheels were equipped with single tires and the rear wheels with dual tires. The wheel base was 14.35 feet. The rear axle carried a load of 16,060 lbs.

The truck, used for the tests made July, 1939, was a Mack (C.H.C. 4106), furnished by the Maintenance Department. The front wheels were equipped with single tires and the rear wheels with dual tires. The front axle carried a load of 5740 lbs. and the rear axle, 14,840 lbs. The wheel base was 13.7'. The tires were 9"X 20"-10 ply inflated to 65 lbs. per square inch.

SOIL.

Character of Subsoil.

The natural soil and imported borrow, comprising the lower part of the fill, is a clay loam soil in texture. Test on samples (Table 12) secured from a depth of 1' to 2' below the bottom of the pavement, indicate this material is an A-4, bordering on an A-5 soil, under the U.S.B.P.R. grouping of subgrade soils. The test results show a range in bearing value, after compacting and soaking, from 2 to 9% (Average 5%) at 0.1" penetration and expansion values (swells) ranging from 4.2% to 7.2% (average 5.9%).

Compaction of Subsoil.

The relative compaction (Table 14, Fig. 20, Fig. 21) samples were secured from approximately 1 to 2' below the bottom of the pavement, with a 7" orchard post hole auger, after the subgrade had been prepared for paving operations. The volume of the test hole was determined by the water displacement method, using a thin rubber bag to line the hole. The density of the material, in place, was then calculated from the dry weight of the sample and the volume of the test hole.

Relative compaction was determined by the California Standard field compaction method. The dry weight, compacted at optimum moisture content, ranged between 118 lbs. and 123 lbs. per cubic foot. The average value of 121.5 lbs. per cubic foot was used for calculating the relative compaction, except as noted below.

A portion of the samples (Table 14) contained somewhat more sand, due to intermixing of sandy imported borrow and natural soil. The compacted dry weight at optimum moisture, as determined by the California field compaction method, ranged from 123 lbs. per cubic foot to 127 lbs. The average value of 125.5 lbs. per cubic foot was used for calculating the relative compaction of this class of material. The relative compaction of the subsoil varied between 87% and 108%, with an average value of 94%.

Moisture Content of Subsoil.

The moisture content of the subsoil during construction, (Fig. 20 and 21) is shown on the soil profile. These samples for moisture content were taken in September, 1938, with a 1" soil sampler.

Moisture content (Table 13, Fig. 22) samples were taken from the relative compaction tests. The samples were secured October 4, 5 and 6, 1938 and the pavement was placed October 25, 26, 27 and 28, 1938.

The moisture content, after the pavement was placed, and at the time deflection measurements were made, are tabulated in Table 10 (Fig. 22). Samples for moisture content reported for November, 1938, were secured from the E locations at the time the reference rods were installed. The samples for moisture content, reported for June, 1937, were secured through the couplings labelled X, Y or Z (Fig. 1). The moisture content of the subsoil varied between 9% and 21% with an average value of 13%.

Character of Subgrade.

The pavement was constructed over a blanket of selected imported borrow, compacted to a thickness of approximately 1'. This material is a sandy loam soil in texture. Tests on samples (Table 11), secured from the 0 to 1' below the bottom of the pavement, class this material as an A-2 soil under the U.S.B.P.R. grouping of subgrade soils. The test results show a range in bearing value, after compacting and soaking, of 19 to 79% at

0.1" penetration and expansion values (swells) ranging from 0.6% to 2.6%. The average bearing value for the group being 49% and the average expansion values (swell) 1.1%.

The relative compaction samples (Table 13, Fig. 20, Fig. 21) of the selected imported borrow, were secured from the top 1' of subgrade, with a 7" orchard post hole auger, after the subgrade had been prepared for paving operations, as described for the subsoil. The density of the material in place, was calculated from the dry weight and volume measurements made in the field.

The relative compaction was determined by the standard California field compaction method. The dry density obtained by the compaction test varied between 126 and 129 lbs. per cubic foot. The average value of 127.5 lbs. per cubic foot was used for calculating the relative compaction. The relative compaction of the subgrade varied between 92% and 105%, with an average value of 98%.

Moisture Content of Subgrade.

The moisture content (Table 14, Fig. 22) samples were taken from the relative compaction tests. These samples were secured October 4, 5, 6, 1938, and the pavement was placed October 25, 26, 27 and 28, 1938.

The moisture content, after the pavement was placed and at the time the deflection readings were made, are tabulated in Table 10 (Fig. 22). Samples for moisture content, reported for November, 1938, were secured from the E location at the time the reference rods were installed. The samples for moisture content, reported for June, 1939, were secured through the couplings labelled X, Y or Z (Fig. 1). The moisture content of the subgrade varies between 7% and 14%, with an average value of 11%.

DISCUSSION OF RESULTS.

The typical oscillograph records (Fig. 5) are for points A-B (Fig. 1) for a truck speed of approximately 15 miles per hour.

The relation between the deflection curve and the position of the rear wheels of the truck passing over the joint, under test, is shown as the center of the jump in the time line. The spacing of the 1' increments of the truck travel are based on the assumption that the truck travels 13.7' (wheel base of the truck) at a uniform speed, and that the film speed was constant, as indicated by uniform spacing of the peaks in the time line. The distance between the center of the jumps in the time line, caused by the front wheels of the truck (not shown on the oscillograph record) and that caused by the rear wheels was divided into 13.7 parts. These increments then represent each foot travel of the truck, compensated for variations in the truck speed and film speed secured for each recording.

The horizontal lines are spaced in accordance with the calibration secured previously with the particular electric gauge head and oscillograph galvanometer used for the test.

A comparison of the average maximum dynamic deflections, (Fig. 7) (Table 4) measured in December, 1938, and July, 1939, indicate somewhat higher deflections for July, 1939. The deflection measurements in December, 1938, were made soon after the pavement had been completed. The moisture content and temperature (Table 1) were uniform through the slab. The deflection measurements in July, 1939, were made after the pavement had been subjected to hot, dry summer weather, causing a non-uniform moisture warping. The readings were also made at night when the temperature (Table 2) of the concrete surface was cooler than the bottom, causing an upward warp or curl in the pavement slab.

The static deflections (Fig. 7, Table 7) are slightly higher than the deflections recorded for the dynamic conditions.

The dynamic readings are the average obtained on three joints of each series, while the static readings are the average obtained on only two joints in each series. This may account for any discrepancies.

The average dynamic differential deflections (Fig. 8, Table 5) measured in December, 1938, differ only slightly from those measured in July, 1939, except for the joints having no load transfer devices. The joints without load transfer devices show a marked increase in differential deflections, due, at least in part, to the warped condition of the pavement.

The static differential deflections (Fig. 8, Table 7) are slightly higher, in most cases, than the differential deflections measured for the dynamic conditions. The dynamic readings are the average obtained on three joints in each series, while the static readings are the average obtained on only two joints in each series. This may account for any discrepancies.

The day and night deflection readings (Fig. 9, Table 6) were taken on a few selected joints at different times during the day and night. The greatest deflection in all cases, were secured at night, the time of greatest upward curl or warp, and the minimum deflections were secured during the day, when the warp or curl was down, causing the pavement slab to be in contact with the subgrade at the joints.

Data for Table 1 were measured on the joints in December, 1938. The pavement, at this period, had not been opened to through traffic but had been used by the contractor's equipment.

The maximum deflections are the actual maximum deflections read from the oscillograph record for the speed shown. The zero or base readings were taken as the no load position of the pavement slab.

The differential deflection for points A and B were measured from the oscillograph records when A was at maximum deflection and again when B was at maximum deflection. The maximum differential deflection for A-B was recorded as the maximum of the two values obtained. The same procedure was followed in obtaining maximum differential values for C-D, from the C-D oscillograph records. The maximum value of differential deflection occurred in some cases, as the truck wheels were approaching the joint and in other cases the maximum was obtained with the truck wheels leaving the joint under test. It is possible that slight differences in subgrade bearing value influenced the extent of the total deflections and are responsible for any inconsistencies.

Data for Table 2 were secured in July, 1939. The pavement had been in use for general traffic. All readings were taken at night, between 10 P.M. and 6 A.M., when the top of the pavement was cooler than the bottom of the pavement, and the pavement had been subjected to dry summer conditions for a considerable period of time.

The deflection data were secured from the oscillograph record, as described for Table 1.

Data for Table 3 were secured in July, 1939, as described for Table 2.

The data shown for expansion and weakened plane joints at various expansion joint intervals were secured for the first time in July, 1939.

Data for the dynamic readings for Table 4 were secured from Table 1 and Table 2. The A deflection averages and the B deflection averages were themselves averaged and shown under A-B for the particular speed. The points D and E were also averaged in the same manner and shown in the table. These dynamic readings represent readings taken on three joints, comprising a joint series.

The data for the static readings for Table 4 were secured from Table 7. The A-B and D-E averaged results were secured in the same manner as for the dynamic readings. The static readings, however, represent only two joints of each series. Static readings were not obtained on the first joint of each series.

The data shown in Table 5 for dynamic maximum differential deflections were secured from the average maximum differential deflections on the group of three joints comprising each series, as shown in Table 1 and Table 2.

Data shown in Table 5 for static maximum differential deflection on the group of two joints comprising each series, as shown in Table 7 for July, 1939.

Data for Table 6 were secured by taking readings in the night and day, as shown, and reading the oscillograph curves as described for Table 1.

Table 7 lists miscellaneous data obtained on the joints in July, 1939. The change in opening across the joints represents the change obtained from readings secured in December, 1938, at the time the original deflection readings were taken. The change in elevation is also the change from December, 1938.

Readings for Table 8 were taken with the truck driven along the center of the right (east) lane. The differential deflections were made by anchoring an iron arm in the left lane about 7" out from the longitudinal joint, opposite points G and H (Fig. 1). The electric gauges were mounted in couplings labelled G and H. The center part of each gauge was suspended from the iron arm instead of being fastened to the reference rod. The readings for maximum deflections were made by connecting the center parts of the electric gauges to the reference rods in the standard manner.

Data for Table 9 were secured from a series of measurements made across the joints between brass plugs cast in the pavement. The base readings were made the day following the placing of the concrete.

The joints in the pavement where the expansion joint spacing is in excess of 60' were cut out to 3/4" joint opening between the time the readings were obtained in June, 1939, and July, 1939.

Soil tests (Table 12) made on samples of the natural soil, indicated a very low supporting power when wet and a large change in volume with a change in moisture content. These tests indicate the necessity for protective measures before laying P. C. concrete pavement.

A protective layer of 1' of selected imported borrow was placed to provide protection against the high swell and low bearing power of the natural material. The test results (Table 11) indicate the selected imported borrow to have a good supporting power when wet and small volume change due to change in moisture content.

The relative compaction obtained on both the top foot of subsoil and subgrade (Table 13, Table 14, Fig. 20, Fig. 21), with very few exceptions, indicate that a very good degree of compaction was obtained throughout the test sections. This would indicate that the pavement is supported on a fairly uniform subgrade which, at least until such time as the natural soil becomes saturated and loses part of its supporting power, offers excellent subgrade support for the P. C. concrete pavement. The layer of selected imported borrow is expected to offer adequate support in case the natural soil becomes saturated and loses part of its present supporting power.

The moisture content of the subgrade and subsoil (Table 13, Table 14, Fig. 20, Fig. 21, Fig. 22) obtained during construction operations, are true only at the time the samples were secured and do not necessarily represent the moisture content of the material at the time it was compacted. The air, during construction, was hot and dry, which allowed for very fast evaporation of water from the subgrade. To counteract this drying condition, water was added to the subgrade frequently, causing the moisture content to change constantly during the construction period.

The moisture content, after the pavement was placed and at the time deflection readings were made (Table 10, Fig. 22) represent the condition of subsoil and subgrade at that time. It is anticipated that the moisture content of the subsoil will increase and may become almost saturated during flood conditions which sometimes prevail in this area.

CONCLUSION.

The test equipment described herein, was assembled and operated and all test measurements made by Assistant Physical Testing Engineer, J. E. Barton, of the Materials and Research Department staff, assisted by the laboratory and district regular staff employees. Barton, likewise, under the general direction of Senior Physical Testing Engineer, O. J. Porter, compiled or supervised the compiling of all data shown in the tables and figures.

T E Stanton

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Materials and Research Engineer

C O D E

Series No.	EXPANSION JOINT load transfer devices	
1	Standard dowels 3/4" round 24" long	
2	Old standard dowels 3/4" round 24" long	
3	Varied dowel spacing 3/4" round 24" long	
4	Thickened edge	none
5	New Jersey	uses channels
6	T. G. bars 3/4" pins--bearing sleeve	
7	National wing bearing 3/4" pins bearing sleeve	
8	"J" bars 3/4" pins bearing sleeve	
9	Translode--uses angles	
10	Caload--3/4" pins--bearing sleeve	
11	National engineering corporation	

Type	Expansion Joint Fillers
S	Standard
I	Illinois--Type C.E. 1000
A	Ace
NJ	New Jersey
T	Translode
N	National
C	Caltype "E"

1st figure indicates type of joint series

2nd figure indicates the number of occurrences of that particular joint back from Station #687+60

Letter indicates type of joint filler

e.g. 8-1-A indicates J bar series--1st occurrence Ace expansion joint filler.

Fig. 1

Plan Showing Arrangement of Test Units

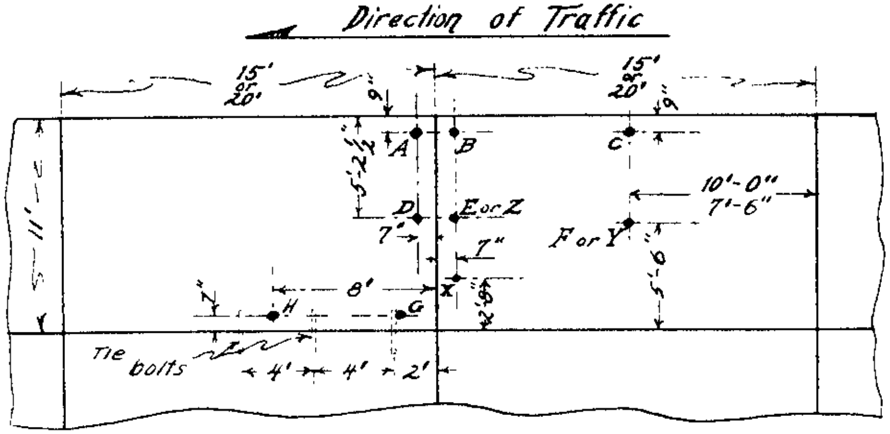


Fig. 3

Method of Measuring Change of Opening Across Joints

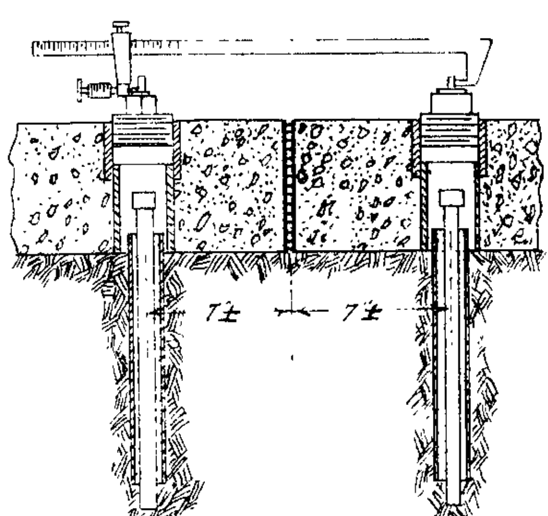
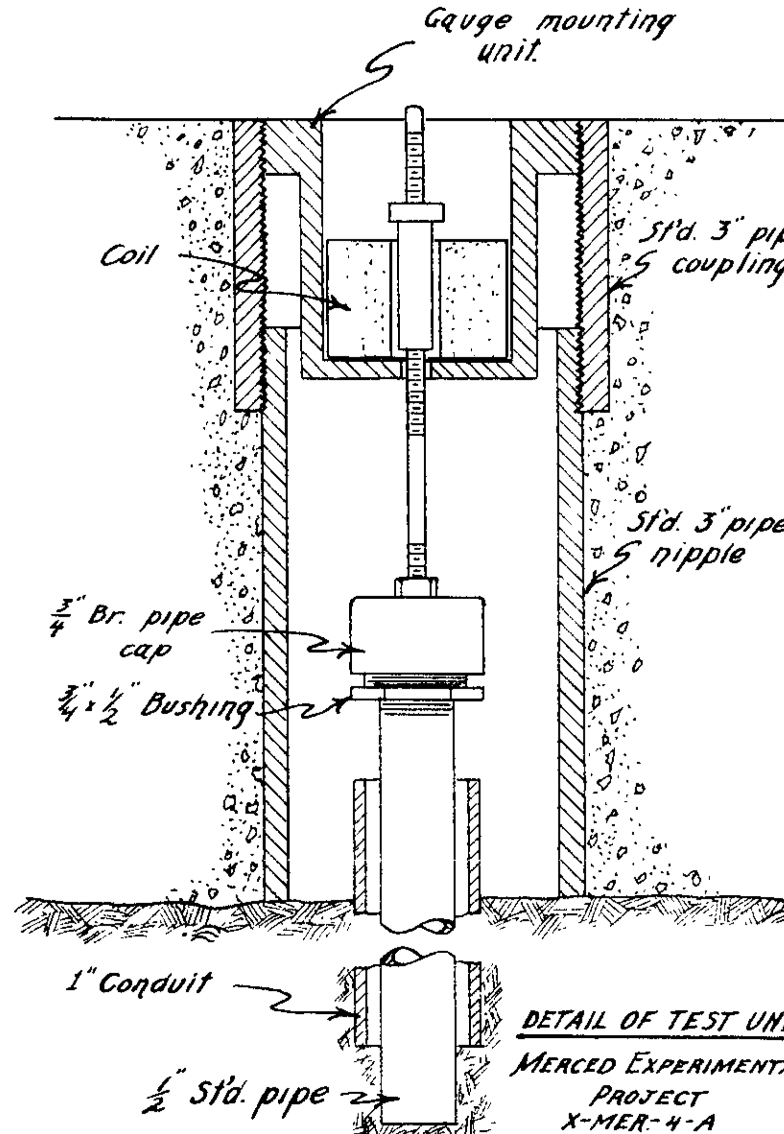


Fig. 2

Section Showing Electric Gauge Installation



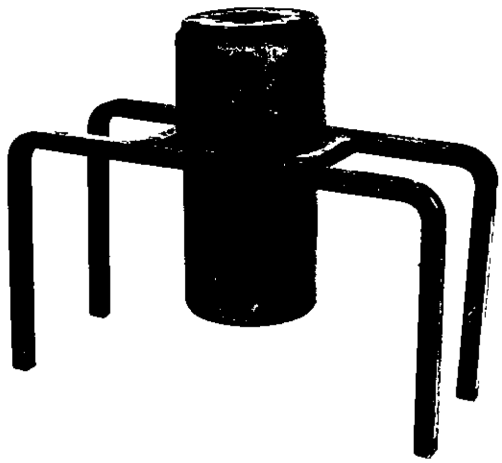
DETAIL OF TEST UNIT

Merced Experimental Project X-MER-4-A

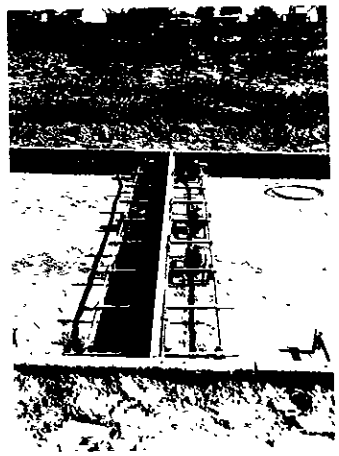
1-7-39

Fig 4

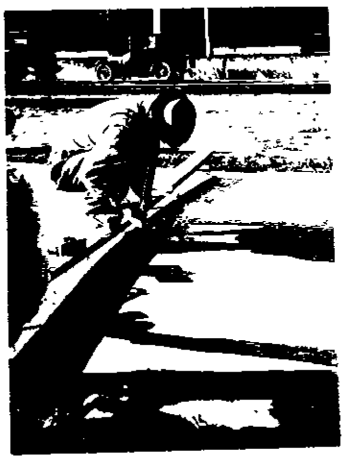
INSTALLING PIPE COUPLING UNITS IN P. C. CONCRETE PAVEMENT FOR MEASURING DEFLECTION OF SLABS WITH ELECTRIC GAUGE



3" coupling unit and chair support

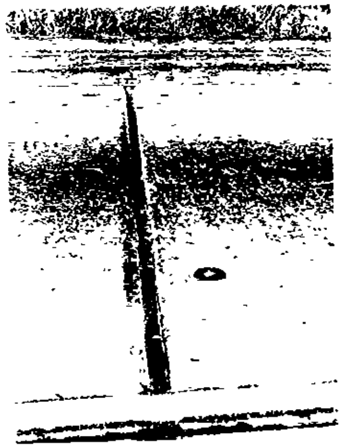


5 sets 1½" below header grade adjacent to each test joint during construction



Locating unit after placing pavement

Raising unit with puller

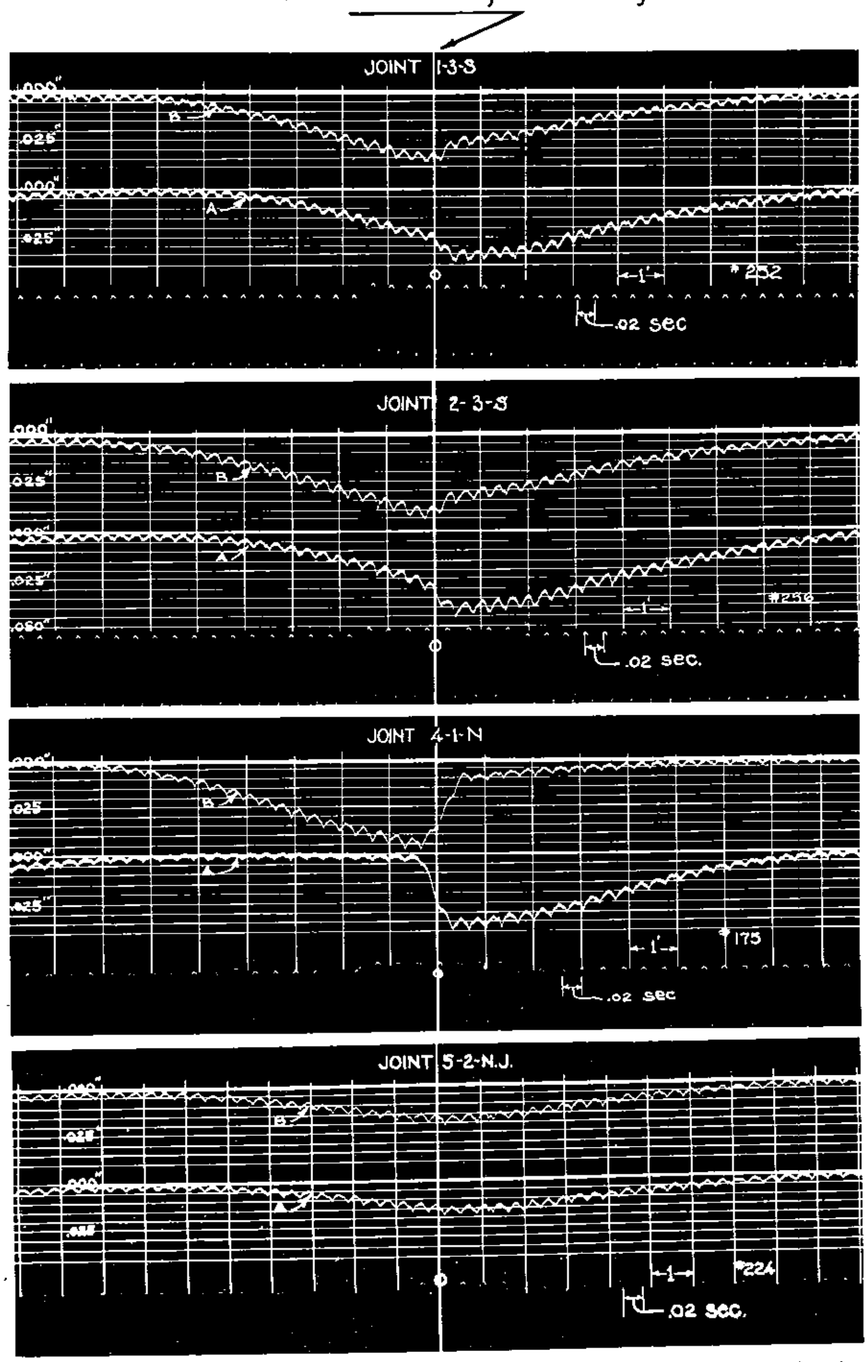


Typical completed test unit

Fig 5

TYPICAL OSCILLOGRAPH RECORDS OF PAVEMENT DEFLECTION UNDER DYNAMIC TRUCK LOADINGS

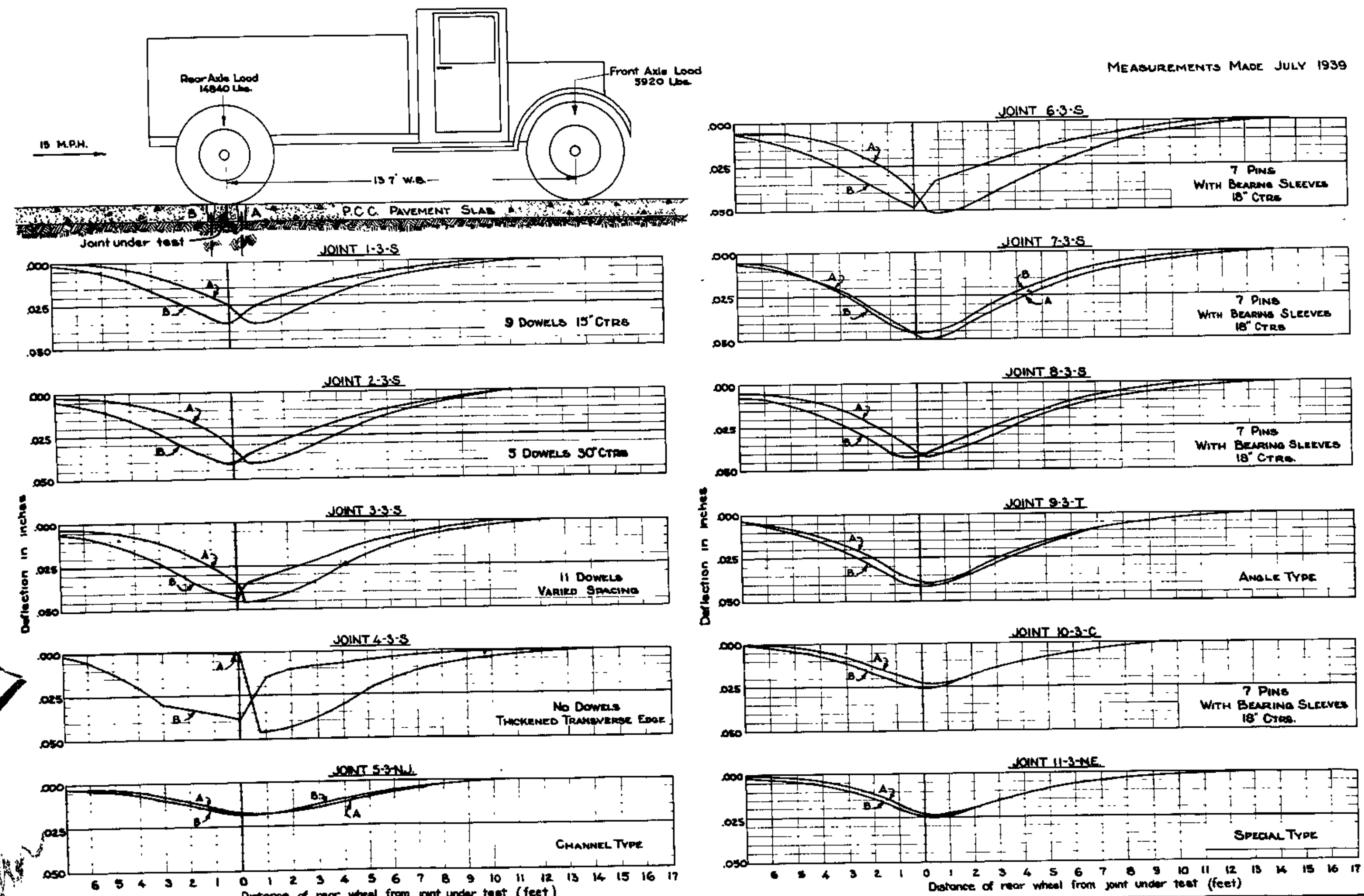
Deflection when the rear axle was directly over the joint



Vertical lines superimposed on film to indicate one foot increments of truck travel
Horizontal lines superimposed on film to indicate .005 inch deflection of pavement.

Fig 6

TYPICAL CURVES SHOWING DEFLECTIONS OF PAVEMENT UNDER DYNAMIC TRUCK LOADING FOR ALL TYPES OF EXPANSION JOINT CONSTRUCTION UNDER TEST



X-Mer. -4-A
July -1939

FIG. 7

COMPARISON OF AVERAGE MAXIMUM DYNAMIC DEFLECTIONS DEC. 1938 AND JULY 1939 AND STATIC DEFLECTIONS - JULY 1939

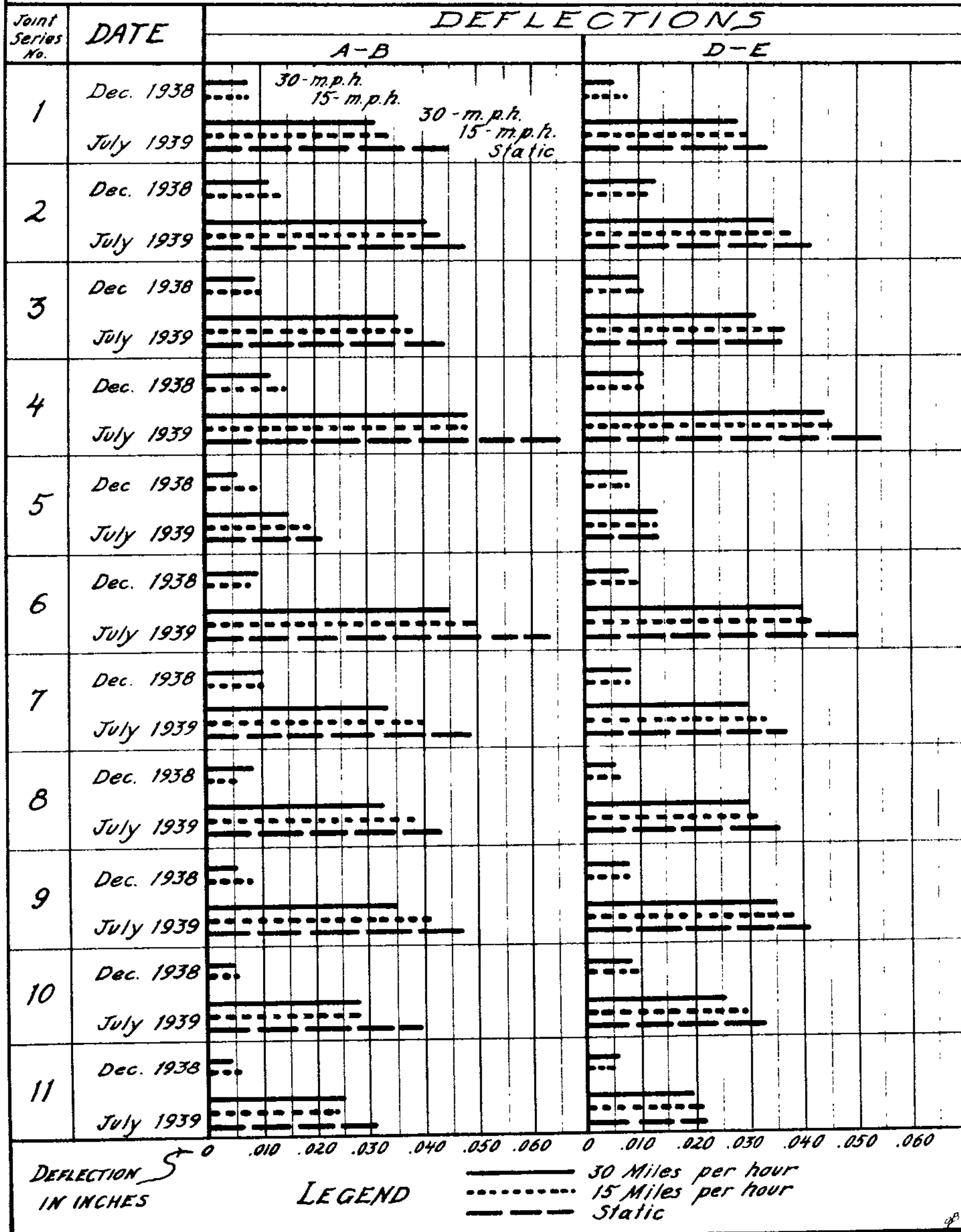
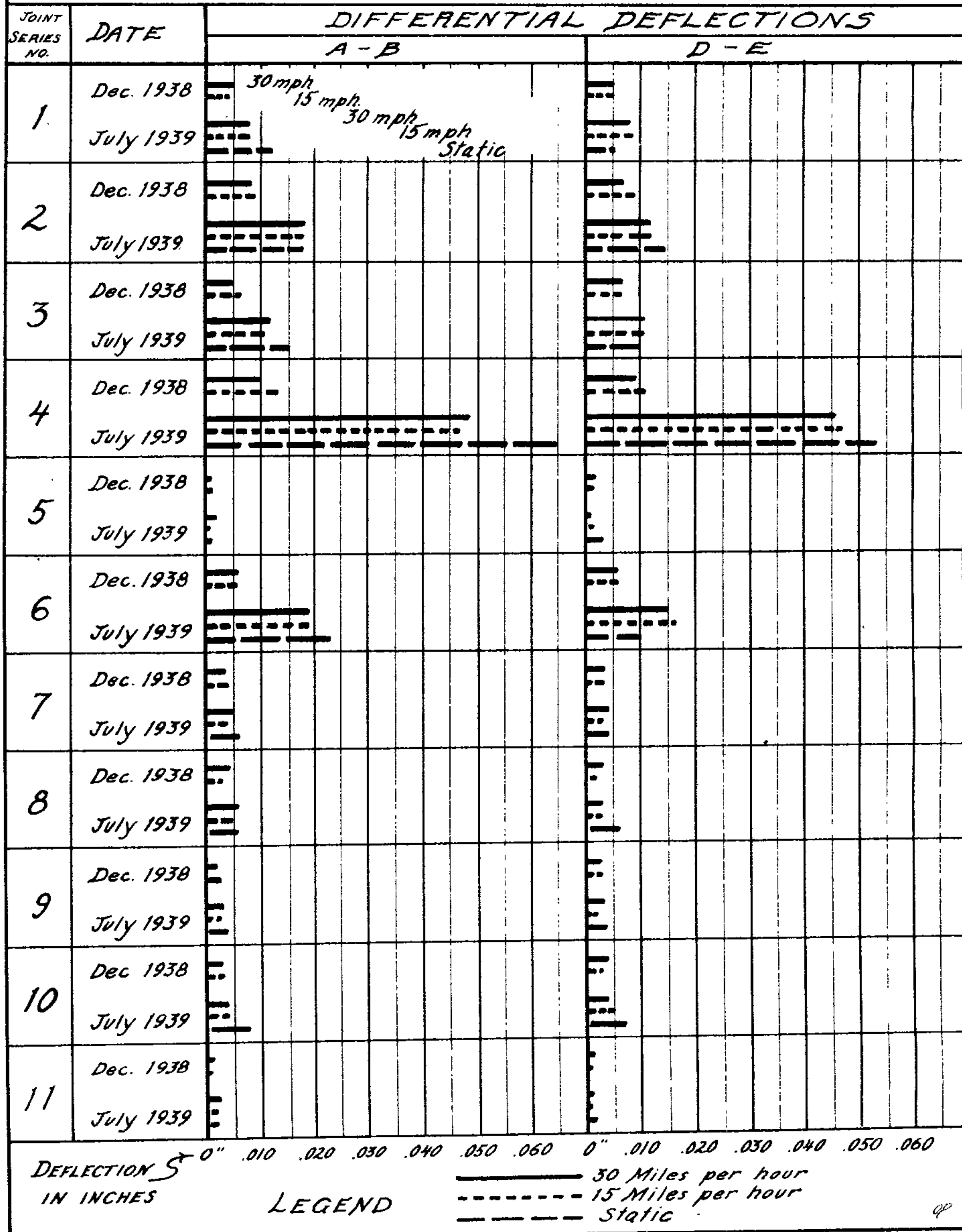


FIG. 8

X-Mer.-4-A
July 1939

COMPARISON OF AVERAGE MAXIMUM DYNAMIC DIFFERENTIAL DEFLECTIONS DEC. 1938 AND JULY 1939 AND STATIC DIFFERENTIAL DEFLECTIONS - JULY 1939

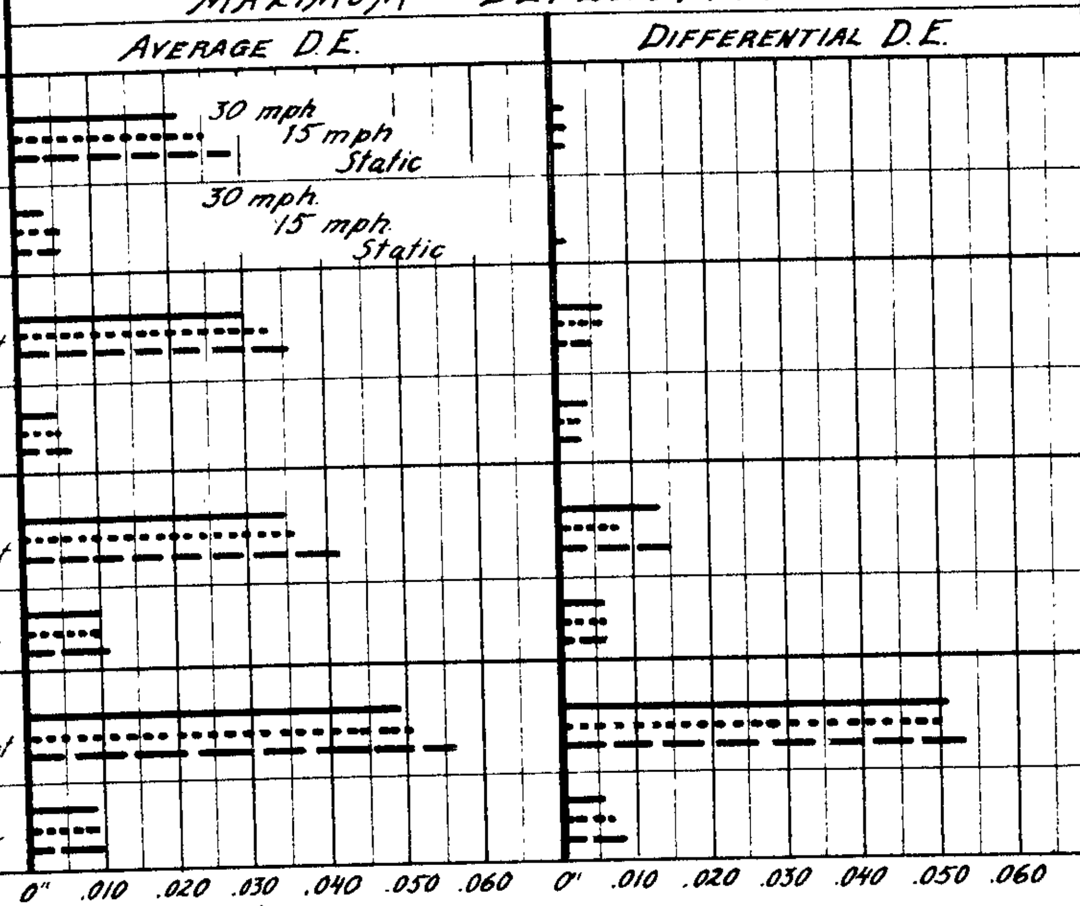


X-Mer.-4-A
July 1939

FIG. 9

COMPARISON OF AVERAGE MAXIMUM DAY AND NIGHT DYNAMIC DEFLECTIONS AND STATIC DEFLECTIONS AT SEVERAL SELECTED POINTS

MAXIMUM DEFLECTIONS



Joint No.		Average Temperature Top	Center	Bottom	Air
11-1 NE	Night	93	98	100	75
	Day	108	101	96	93
1-2 S	Night	91	94	95	72
	Day	108	101	96	93
2-2 S	Night	91	96	97	71
	Day	108	106	105	93
4-2 S	Night	87	92	95	69
	Day	108	108	101	94

Deflection in inches

LEGEND

30 Miles per hour } Dynamic
15 Miles per hour }
Static

Fig 10

ELECTRIC GAUGE HEAD

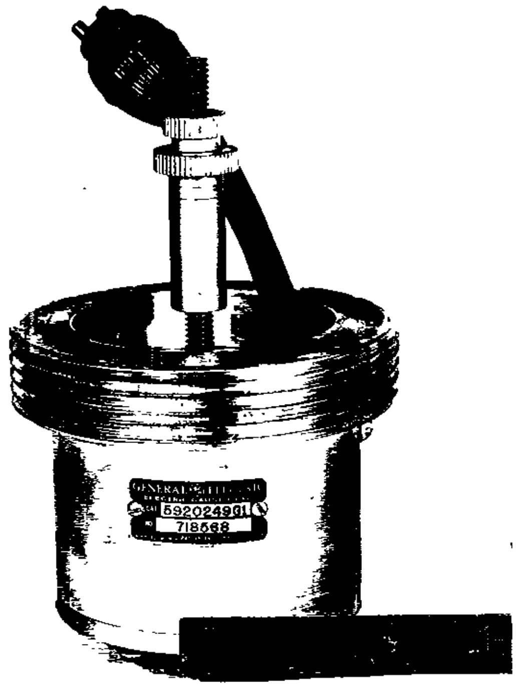


Fig 11

ELECTRIC GAUGE
POWER UNIT & BALANCING UNIT

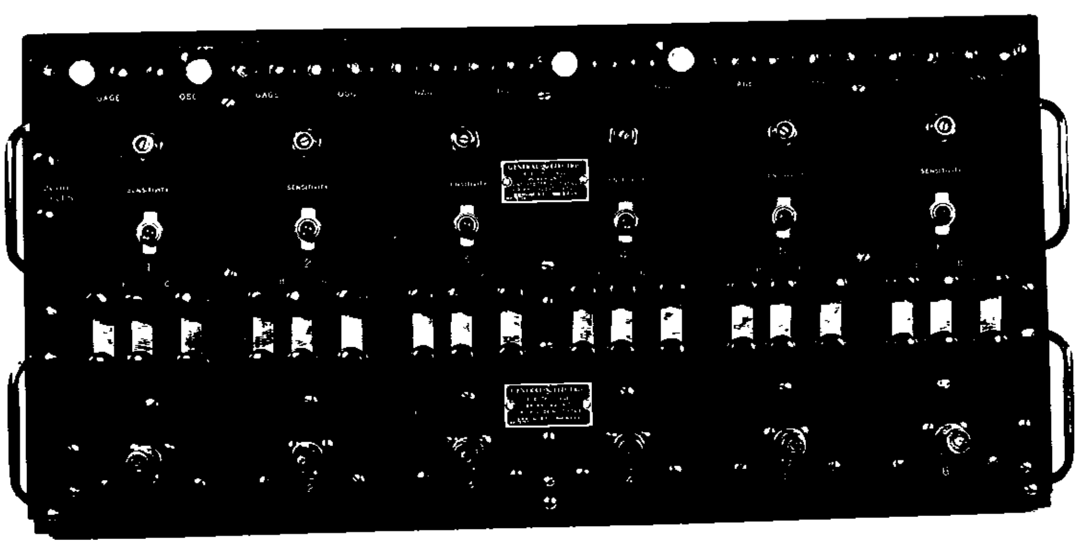


Fig. 12

SCHEMATIC WIRING DIAGRAM OF ELECTRIC GAUGE CIRCUIT

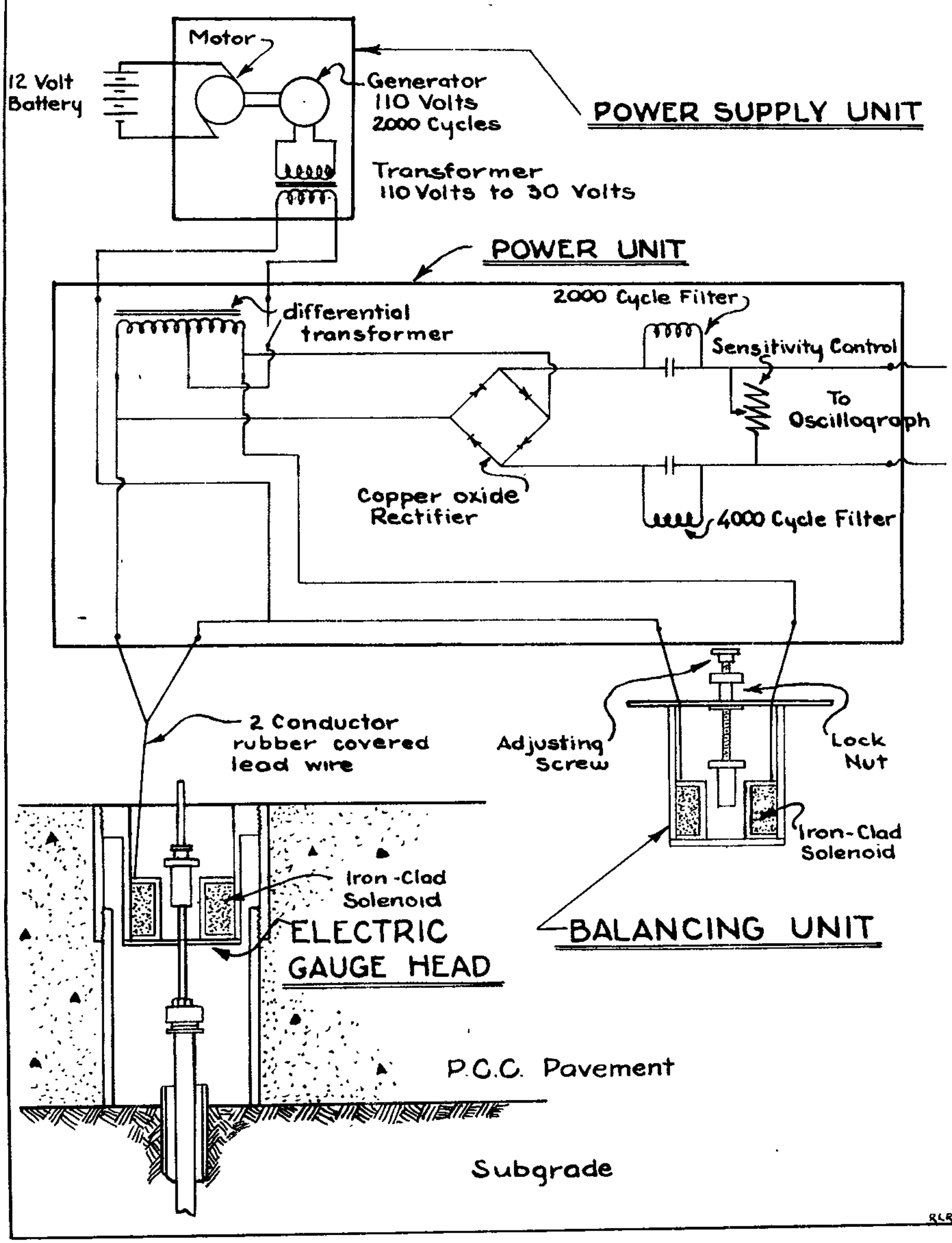
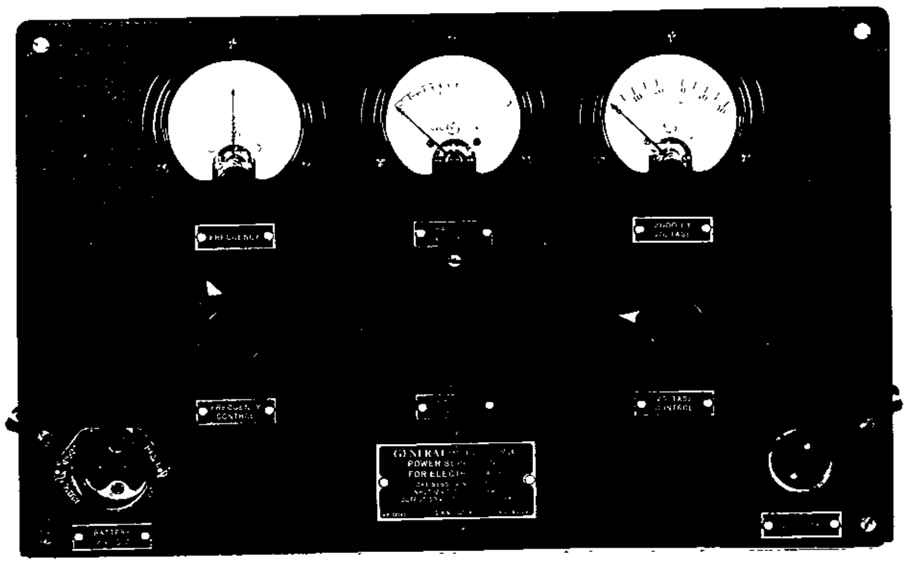
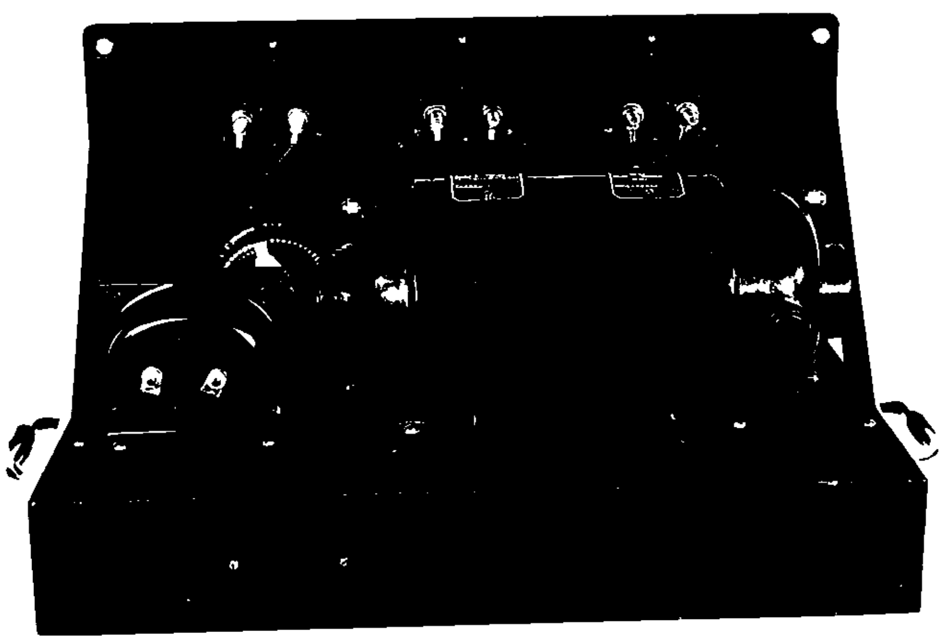


Fig. 13

POWER SUPPLY UNIT FOR ELECTRIC GAUGE

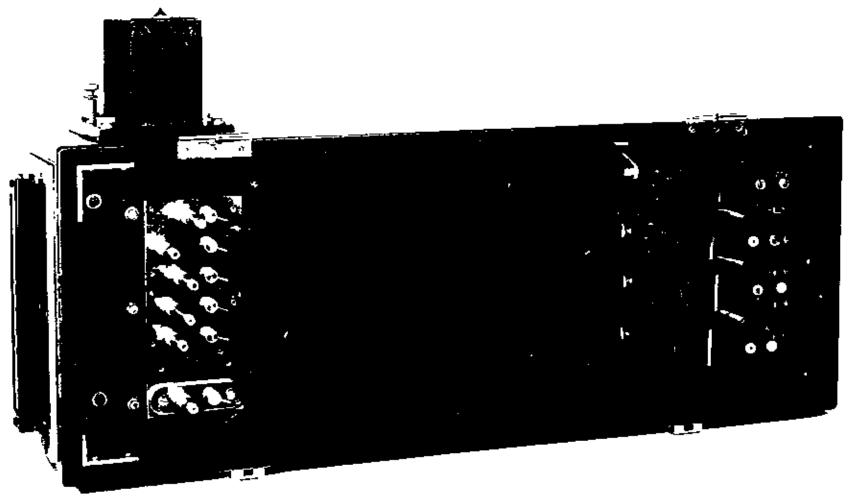


Front View

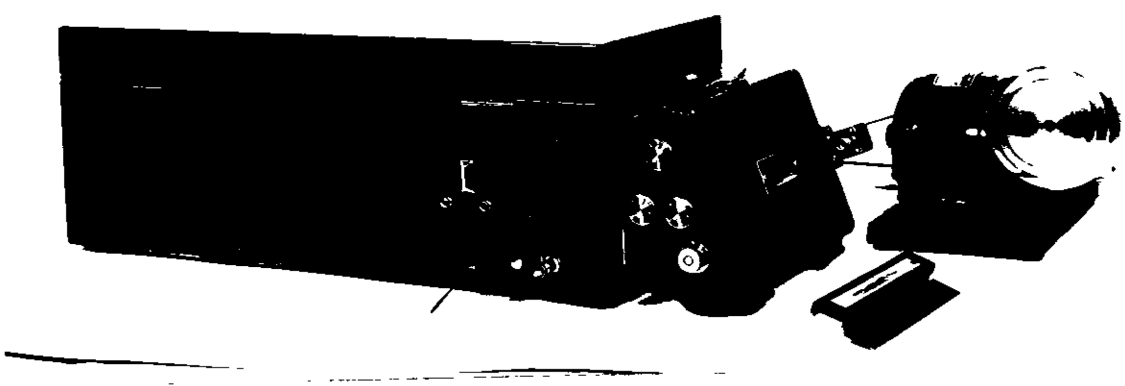


Rear View

Fig 14.



G.E. Type P.M.-14 Oscillograph
with 4 supersensitive Galvanometers
and calibrating screen



G.E. Type P.M.-14 Oscillograph
with continuous drive film holder
and 6 volt D.C. motor driving unit

Fig 15

PHOTO ELECTRIC RELAY & LIGHT SOURCE

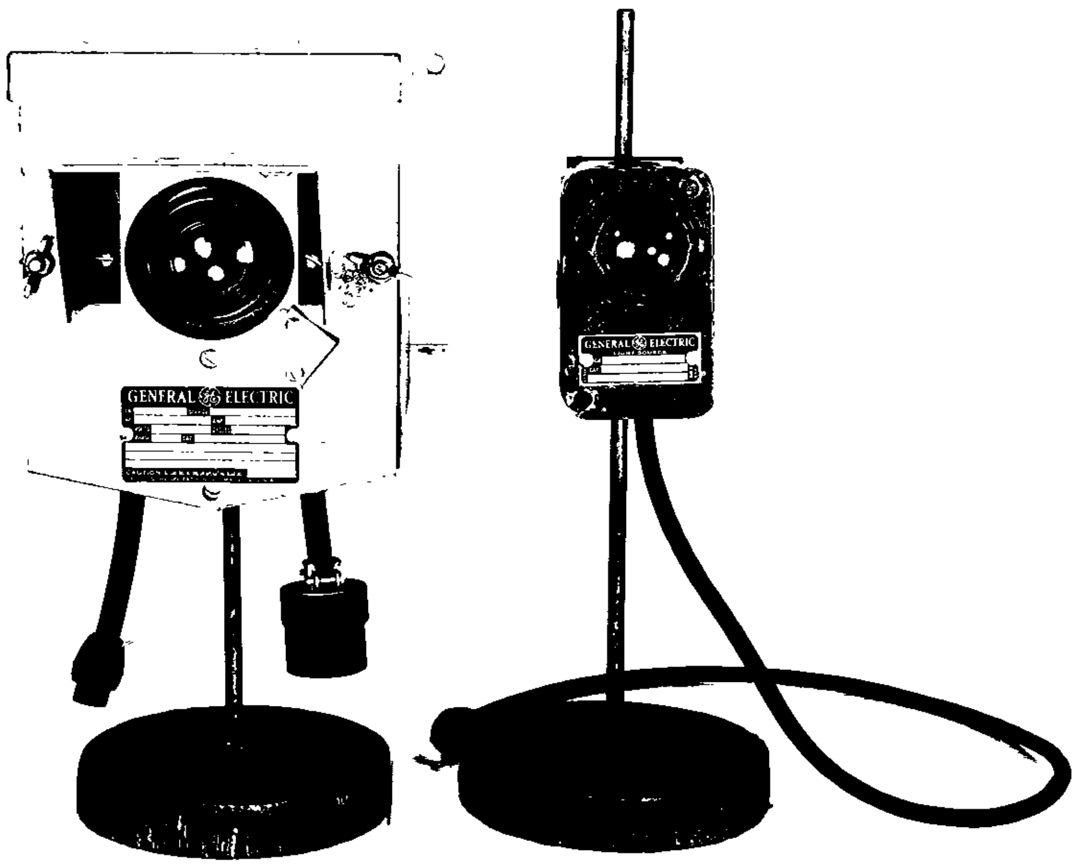


Fig. 16

TYPICAL OSCILLOGRAPH-GAUGE DEFLECTION CURVE

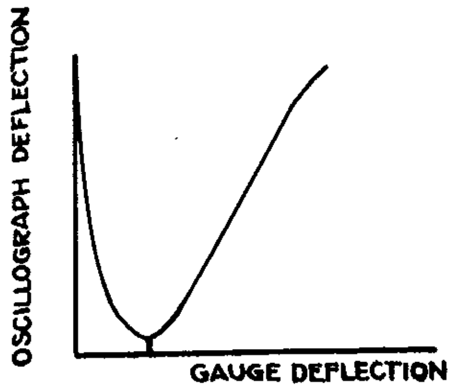
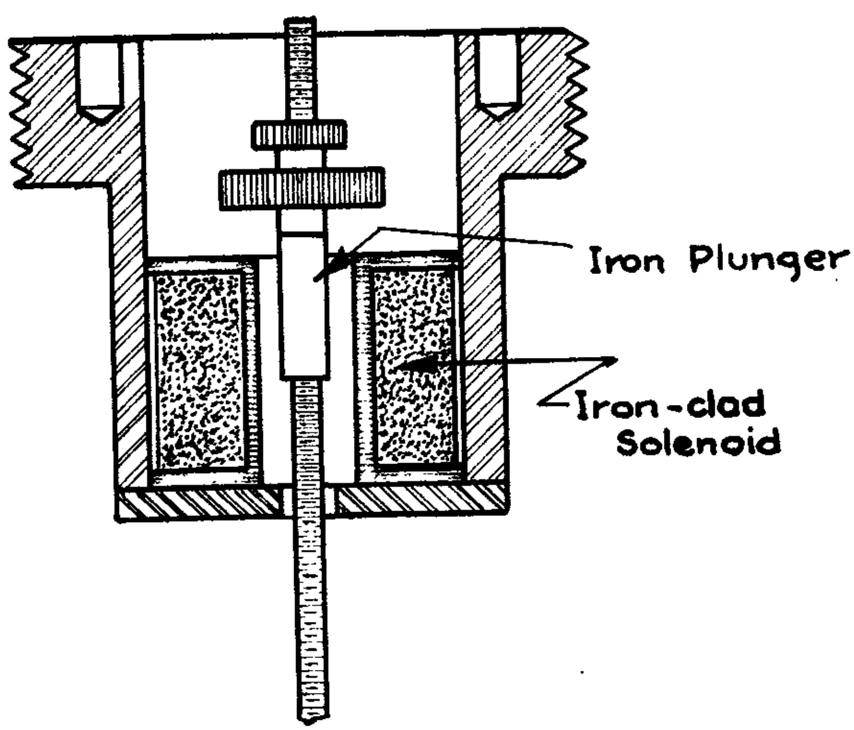


Fig. 17

CROSS-SECTION ELECTRIC GAUGE HEAD



RLR

Fig 18

CALIBRATING DEVICE
FOR ELECTRIC GAUGE HEADS

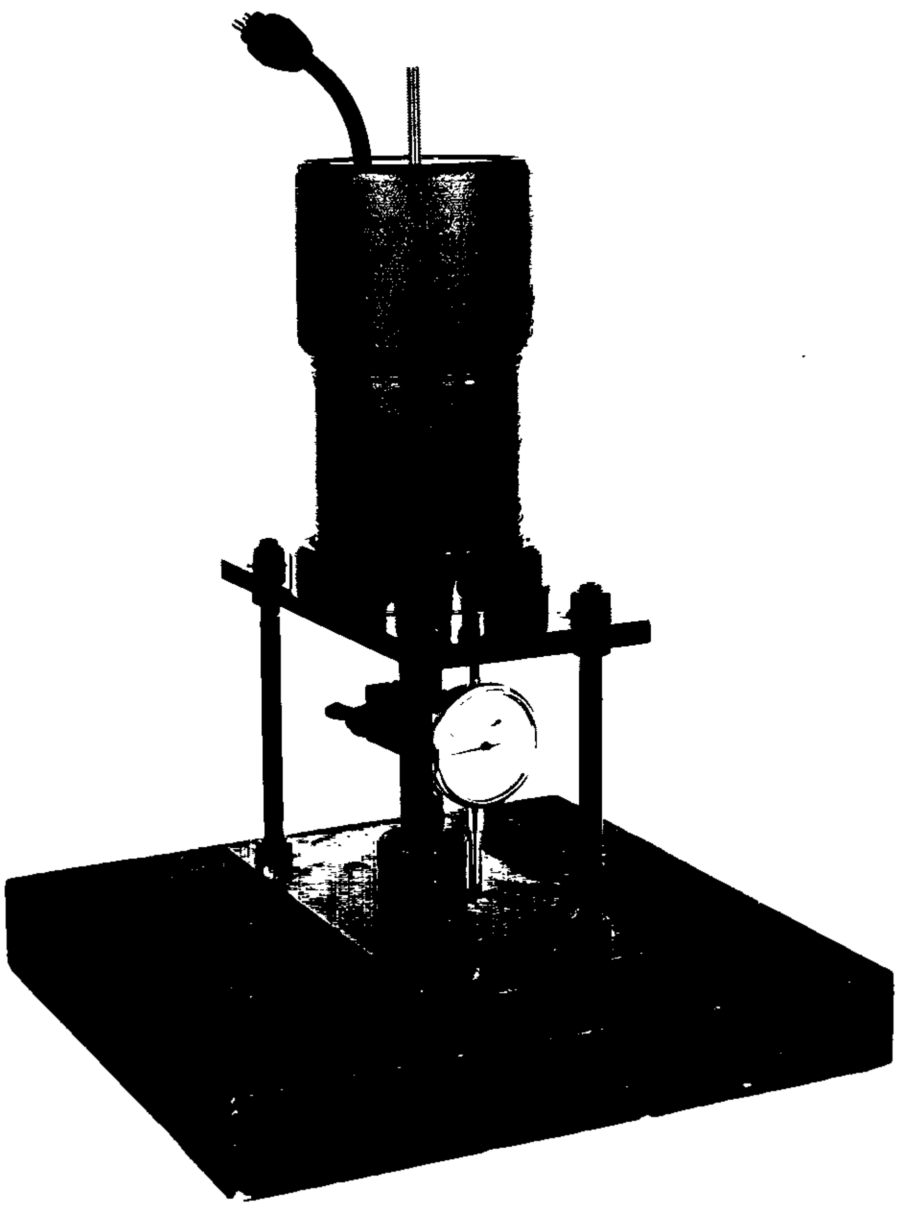
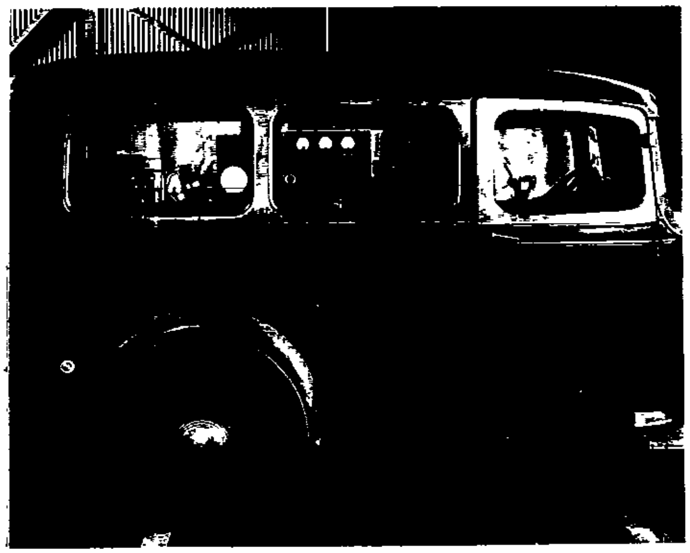


Fig 19

ELECTRIC GAUGE EQUIPMENT
MOUNTED IN STATION WAGON



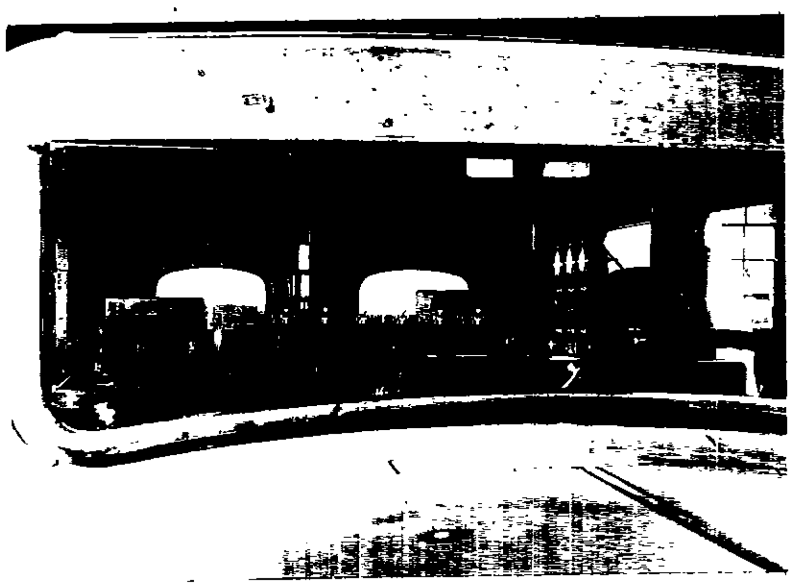


TABLE I

DEFLECTION OF PAVEMENT UNDER REAR WHEELS--16,060# REAR AXLE LOAD

Joint No.		Avg. Speed 30 Mi/Hr.							Avg. Speed 15 Mi/Hr.						Temperature °F		
		Max. Deflection					Maximum Differential		Max. Deflection				Maximum Differential		Top	Center	Bottom
		A	B	C	D	E	AB	DE	A	B	D	E	AB	DE			
1	1-I	.009"	.010"	.003"	.010"	.011"	.005"	.006"	.010"	.009"	.010"	.011"	.002"	.006"	51	52	52
	2-S	.010"	.010"		.004"	.003"	.006"	.003"	.010"	.008"	.005"	.004"	.003"	.003"	47	48	51
	3-S	.004"	.005"		.008"	.005"	.003"	.006"	.007"	.008"	.008"	.008"	.006"	.006"	49	48	49
	Avg.	.008"	.008"		.007"	.006"	.005"	.005"	.009"	.008"	.008"	.008"	.004"	.005"			
2	1-A	.015"	.018"	.005"	.013"	.015"	.011"	.007"	.014"	.017"	.011"	.015"	.011"	.009"	49	50	51
	2-S	.014"	.014"		.016"	.014"	.010"	.010"	.019"	.016"	.016"	.015"	.011"	.010"	47	48	49
	3-S	.008"	.008"		.011"	.009"	.004"	.005"	.008"	.010"	.009"	.010"	.006"	.008"	49	48	49
	Avg.	.012"	.013"		.013"	.013"	.008"	.007"	.014"	.014"	.012"	.013"	.009"	.009"			
3	1-I	.011"	.014"	.003"	.011"	.011"	.006"	.006"	.011"	.013"	.012"	.012"	.006"	.005"	49	49	48
	2-S	.010"	.006"		.011"	.011"	.006"	.008"	.013"	.010"	.013"	.011"	.006"	.006"	47	48	49
	3-S	.006"	.007"		.009"	.007"	.004"	.007"	.008"	.008"	.010"	.008"	.006"	.007"	50	49	49
	Avg.	.009"	.009"		.010"	.010"	.005"	.007"	.011"	.010"	.012"	.010"	.006"	.006"			
4	1-N	.010"	.010"	.004"	.010"	.010"	.006"	.006"	.010"	.011"	.009"	.008"	.006"	.006"	49	49	48
	2-S	.014"	.015"		.014"	.011"	.014"	.011"	.019"	.018"	.016"	.012"	.019"	.016"	47	48	49
	3-S	.008"	.011"		.011"	.009"	.010"	.010"	.009"	.014"	.012"	.011"	.014"	.012"	50	49	49
	Avg.	.011"	.012"		.012"	.010"	.010"	.009"	.013"	.014"	.012"	.010"	.013"	.011"			
5	1-NJ	.008"	.008"	.004"	.010"	.010"	.001"	.002"	.010"	.010"	.011"	.011"	.002"	.002"	49	49	48
	2-NJ	.005"	.006"		.008"	.007"	.001"	.002"	.009"	.008"	.007"	.008"	.001"	.002"	47	48	49
	3-NJ	.004"	.003"		.005"	.004"	.002"	.002"	.010"	.006"	.005"	.004"	.001"	.002"	47	45	44
	Avg.	.006"	.006"		.008"	.007"	.001"	.002"	.010"	.008"	.008"	.008"	.001"	.002"			
6	1-A	.011"	.011"		.010"	.011"	.006"	.007"	.009"	.010"	.011"	.011"	.005"	.005"	49	49	48
	2-S	.008"	.009"		.008"	.010"	.006"	.005"	.007"	.011"	.010"	.011"	.008"	.006"	44	45	48
	3-S	.007"	.006"		.007"	.007"	.005"	.006"	.006"	.007"	.008"	.008"	.005"	.007"	47	45	44
	Avg.	.009"	.009"		.008"	.009"	.006"	.006"	.007"	.009"	.010"	.010"	.006"	.006"			
7	1-N	.017"	.016"	.004"	.010"	.011"	.002"	.003"	.017"	.014"	.011"	.011"	.003"	.003"	49	49	48
	2-S	.009"	.007"		.008"	.006"	.003"	.003"	.010"	.008"	.008"	.008"	.005"	.003"	47	47	45
	3-S	.004"	.003"		.006"	.004"	.003"	.003"	.006"	.004"	.007"	.005"	.004"	.003"	47	45	44
	Avg.	.010"	.009"		.008"	.007"	.003"	.003"	.011"	.009"	.009"	.008"	.004"	.003"			
8	1-A	.009"	.010"	.003"	.008"	.006"	.004"	.003"	.007"	.007"	.007"	.007"	.002"	.002"	47	48	51
	2-S	.006"	.008"		.006"	.006"	.004"	.002"	.006"	.005"	.006"	.006"	.002"	.002"	47	47	45
	3-S	.006"	.005"		.007"	.005"	.004"	.003"	.008"	.006"	.008"	.007"	.004"	.003"	47	46	46
	Avg.	.007"	.008"		.007"	.006"	.004"	.003"	.007"	.006"	.007"	.007"	.003"	.002"			
9	1-T	.008"	.007"	.004"	.010"	.009"	.002"	.004"	.010"	.010"	.010"	.010"	.002"	.004"	47	48	51
	2-T	.006"	.006"		.009"	.008"	.001"	.002"	.008"	.005"	.006"	.006"	.003"	.002"	49	46	47
	3-T	.005"	.004"		.008"	.005"	.002"	.004"	.007"	.006"	.008"	.006"	.004"	.004"	47	46	46
	Avg.	.006"	.006"		.009"	.007"	.002"	.003"	.008"	.007"	.008"	.007"	.003"	.003"			
10	1-C	.			.010"	.010"		.005"			.010"	.010"		.003"	47	48	51
	2-C	.006"	.004"		.006"	.006"	.002"	.002"	.006"	.004"	.008"	.008"	.002"	.002"	49	46	47
	3-C	.006"	.004"		.008"	.008"	.004"	.005"	.007"	.006"	.009"	.008"	.004"	.005"	47	46	46
	Avg.	.006"	.004"		.008"	.008"	.003"	.004"	.006"	.005"	.009"	.009"	.003"	.003"			
11	1-NE	.007"	.007"	.003"	.009"	.008"	.001"	.001"	.010"	.009"	.008"	.008"	.001"	.002"	47	48	51
	2-NE	.003"	.003"		.004"	.003"	.000"	.001"	.004"	.003"	.004"	.003"	.001"	.001"	49	48	49
	3-NE	.003"	.003"		.004"	.003"	.001"	.001"	.004"	.004"	.004"	.004"	.001"	.001"	49	48	49
	Avg.	.004"	.004"		.006"	.005"	.001"	.001"	.006"	.0C5"	.005"	.005"	.001"	.001"			
C 7	3-3C	.003"	.003"	.002"	.003"	.003"			.003"	.003"	.006"	.003"			47	46	44
	5-3C	.003"	.003"	.003"	.003"	.002"			.003"	.003"	.003"	.003"			47	46	44
	4-5C	.003"	.003"	.003"	.003"	.002"			.003"	.003"	.003"	.002"			47	46	44
	2-7C	.003"	.003"	.002"	.003"	.003"			.003"	.003"	.002"	.002"			47	46	44
	1-7C	.003"	.003"	.003"	.003"	.003"			.003"	.003"	.003"	.003"			47	46	44
29,690 POUNDS LOAD ON DUAL REAR AXLE																	
11-2-NE		.008"	.005"		.005"	.004"	.004"	.002"	.007"	.005"	.004"	.004"	.003"	.003"	47	46	44
1-2-S		.007"	.007"				.005"	.	.007"	.007"	.		.005"		47	46	44

X-Mer-4-A
July, 1939

TABLE 2

DEFLECTION OF PAVEMENT UNDER REAR WHEELS--14,840# REAR AXLE LOAD

Joint No.		Avg. Speed 30 Mi/Hr.							Avg. Speed 15 Mi/Hr.						Temp. °F		
		Max. Deflection					Maximum Differential		Max. Deflection				Maximum Differential		Top	Center	Bottom
		A	B	C	D	E	AB	DE	A	B	D	E	AB	DE			
1	1-I	.032"	.031"	.008"	.021"	.028"	.007"	.010"	.031"	.030"	.024"	.029"	.005"	.011"	100	109	112
	2-S	.032"	.028"		.034"	.031"	.005"	.007"	.038"	.033"	.036"	.032"	.007"	.007"	93	95	93
	3-S	.034"	.031"		.029"	.028"	.011"	.008"	.037"	.036"	.030"	.030"	.013"	.008"	92	97	97
	Avg.	.033"	.030"		.028"	.029"	.008"	.008"	.035"	.033"	.030"	.030"	.008"	.009"			
2	1-A	.038"	.040"	.008"	.034"	.036"	.019"	.015"	.043"	.046"	.036"	.037"	.022"	.013"	100	109	112
	2-S	.046"	.037"		.039"	.033"	.022"	.015"	.046"	.041"			.019"		89	93	93
	3-S	.041"	.042"		.036"	.032"	.014"	.008"	.041"	.042"	.040"	.037"	.012"	.012"	91	97	97
	Avg.	.042"	.040"		.036"	.034"	.018"	.013"	.043"	.043"	.038"	.037"	.018"	.012"			
3	1-I	.033"	.032"	.008"	.034"	.032"	.004"	.010"	.036"	.034"	.036"	.035"	.005"	.012"	98	107	110
	2-S	.030"	.032"		.029"	.027"	.014"	.009"	.032"	.034"	.039"	.030"	.013"	.009"	86	91	92
	3-S	.046"	.041"		.036"	.037"	.017"	.013"	.046"	.043"	.040"	.040"	.013"	.011"	90	96	98
	Avg.	.036"	.035"		.033"	.032"	.012"	.011"	.038"	.037"	.038"	.035"	.010"	.011"			
4	1-N	.039"	.048"	.010"	.032"	.038"	.046"	.036"	.036"	.045"	.031"	.039"	.042"	.037"	97	103	107
	2-S	.044"	.057"		.045"	.054"	.053"	.050"	.050"	.065"	.050"	.057"	.062"	.051"	84	90	92
	3-S	.054"	.042"		.046"	.051"	.050"	.051"	.048"	.037"	.048"	.053"	.037"	.053"	90	96	98
	3-S	.046"	.058"		.039"	.046"	.058"	.046"	.045"	.054"	.041"	.047"	.048"	.047"	87	92	94
	Avg.	.046"	.051"		.040"	.047"	.052"	.046"	.045"	.050"	.042"	.049"	.047"	.047"			
5	1-NJ	.018"	.020"	.007"	.017"	.017"	.002"	.000"	.022"	.022"	.017"	.017"	.000"	.000"	96	100	104
	2-NJ	.016"	.020"		.012"	.014"	.004"	.002"	.015"	.018"			.003"		82	90	92
	3-NJ								.018"	.018"	.011"	.014"	.000"	.003"	88	92	94
	3-NJ	.016"	.016"		.010"	.011"	.000"	.001"	.019"	.018"	.010"	.012"	.001"	.002"	88	94	94
	Avg.	.017"	.019"		.013"	.014"	.002"	.001"	.019"	.019"	.013"	.014"	.001"	.001"			
6	1-A	.041"	.046"		.033"	.035"	.025"	.016"	.045"	.047"	.035"	.037"	.023"	.016"	91	96	99
	2-S	.046"	.047"		.038"	.044"	.013"	.014"	.052"	.054"	.042"	.047"	.014"	.013"	80	88	92
	3-S	.049"	.042"		.043"	.044"	.019"	.015"	.052"	.049"	.046"	.048"	.019"	.018"	88	93	94
	Avg.	.045"	.045"		.038"	.041"	.019"	.015"	.050"	.050"	.041"	.044"	.019"	.016"			
7	1-N	.026"	.027"	.012"	.025"	.026"	.005"	.005"	.038"	.039"	.029"	.030"	.006"	.005"	88	93	96
	2-S	.032"	.033"		.028"	.030"	.006"	.004"	.032"	.031"	.030"	.032"	.001"	.003"	102	106	111
	3-S	.042"	.039"		.034"	.037"	.003"	.004"	.050"	.046"	.037"	.039"	.006"	.002"	88	91	92
	Avg.	.033"	.033"		.029"	.031"	.005"	.004"	.040"	.039"	.032"	.034"	.004"	.003"			
8	1-A	.027"	.029"	.005"	.030"	.031"	.005"	.003"	.035"	.036"	.032"	.032"	.005"	.002"	86	91	94
	2-S	.027"	.028"		.026"	.026"	.004"	.003"	.032"	.034"	.029"	.027"	.005"	.005"	100	104	108
	3-S	.046"	.043"		.033"	.031"	.009"	.005"	.043"	.043"	.035"	.033"	.006"	.003"	88	90	91
	Avg.	.033"	.033"		.030"	.029"	.006"	.004"	.037"	.038"	.032"	.031"	.005"	.003"			
9	1-T	.033"	.034"	.007"	.033"	.033"	.004"	.001"	.043"	.046"	.036"	.036"	.004"	.002"	82	85	88
	2-T	.037"	.034"		.034"	.035"	.003"	.004"	.036"	.035"	.036"	.037"	.001"	.004"	99	103	106
	3-T	.036"	.038"		.037"	.038"	.002"	.005"	.039"	.041"	.039"	.040"	.002"	.001"	88	91	93
	Avg.	.035"	.035"		.035"	.035"	.003"	.003"	.039"	.041"	.037"	.038"	.002"	.002"			
10	1-C			.005	.026"	.024"		.003"			.029"	.027"		.003"	100	105	108
	2-C	.028"	.026"		.029"	.026"	.005"	.005"	.033"	.031"	.032"	.027"	.006"	.007"	98	102	103
	3-C	.030"	.030"		.026"	.028"	.004"	.006"	.024"	.026"	.028"	.031"	.003"	.006"	88	90	91
	Avg.	.029"	.028"		.027"	.026"	.004"	.005"	.028"	.028"	.030"	.028"	.004"	.005"			
11	1-NE	.028"	.026"	.007"	.022"	.022"	.002"	.002"	.026"	.024"	.024"	.024"	.002"	.001"	98	103	106
	2-NE	.022"	.022"		.015"	.014"	.002"	.001"	.021"	.024"	.015"	.014"	.003"	.002"	97	101	101
	3-NE	.026"	.027"		.020"	.021"	.001"	.001"	.024"	.025"	.023"	.024"	.001"	.001"	86	90	91
	Avg.	.025"	.025"		.019"	.019"	.002"	.001"	.024"	.024"	.021"	.021"	.002"	.001"			

X-Mer-4-A
July, 1939

TABLE 3

DEFLECTION OF PAVEMENT UNDER REAR WHEELS--14,840# REAR AXLE LOAD

Joint No.	Avg. Speed 30 Mi/Hr. Max. Deflection A	B	C	D	E	Maximum Differential AB	DE	Avg. Speed 15 Mi/Hr. Max. Deflection A	B	D	E	Maximum Differential AB	DE	Temp. °F Top	Center	Bottom
C 7 6-3C 5-3C 4-5C 2-7C 1-7C	.015" .016" .011" .018" .013"	.016" .018" .013" .019" .016"	.006" .007"	.013" .012" .011" .017" .014"	.012" .011" .012" .018" .015"	.001" .002" .002" .001" .003"	.001" .001" .001" .001" .001"	.017" .012" .012" .025" .013"	.018" .013" .015" .026" .016"	.013" .013" .011" .018" .014"	.015" .012" .011" .019" .015"	.001" .001" .003" .001" .003"	.002" .001" .000" .001" .001"	86 86 88 88 90	89 93 94 92 96	93 96 96 96 97
Station	Standard expansion joints--60' intervals--Standard weakened plane--2 dowels--15' intervals															
474-50C 475+10C				.022" .017"	.030" .021"		.013" .005"			.024" .021"	.032" .023"		.016" .005"	79 81	85 87	86 88
	Standard expansion joints--60' intervals--Standard weakened plane--no dowels--15' intervals															
480+50C 481+10C				.019" .018"	.025" .024"		.009" .007"			.024" .021"	.028" .025"		.008" .005"	80 82	88 89	90 91
	Standard expansion joints--120' intervals--Standard weakened plane--no dowels--15' intervals															
485+00C 485+60E 486+20C	.019"	.024"		.020" .021" .022"	.028" .024" .025"	.005"	.011" .007" .004"	.020"	.026"	.024" .023" .024"	.028" .026" .025"	.007"	.009" .008" .005"	83 78 88	90 83 95	92 83 97
	3/4" thickened edge exp. joints--9 dowels--210' intervals--Std. weakened plane--no dowels--15' intervals															
489+05C 490+10E 491+15C	.020"	.023"		.024" .018" .017"	.032" .020" .018"	.009"	.014" .006" .001"	.022"	.023"	.029" .021" .019"	.033" .020" .019"	.006"	.011" .004" .002"	76 76 90	80 80 96	81 81 98
	3/4" thickened edge exp. joints--9 dowels--300' intervals--Std. weakened plane--no dowels--15' intervals															
503+50C 505+00E 506+50C	.015"	.016"		.018" .013" .010"	.021" .014" .012"	.006"	.003" .005" .002"	.017"	.016"	.020" .013" .012"	.023" .015" .014"	.004"	.003" .005" .002"	92 94 95	98 100 101	100 101 102
	3/4" thickened edge exp. joints--9 dowels--405' intervals--Std. weakened plane--no dowels--15' intervals															
512+00E 513+05C 513+95C				.026" .012" .013"	.027" .015" .016"		.001" .003" .003"			.019" .012" .015"	.022" .015" .017"		.003" .003" .002"	84 85 87	86 88 90	89 91 94
	3/4" thickened edge exp. joints--9 dowels--510' intervals--Std. weakened plane--no dowels--15' intervals															
528+60C 529+35C 530+55C				.013" .013" .010"	.018" .021" .014"		.005" .008" .004"			.013" .014" .012"	.018" .023" .016"		.005" .009" .004"	88 87 86	92 92 93	96 96 96

Suffix C indicates weakened plane joints
Suffix E indicates expansion joints

TABLE # 4

Comparison of Average Maximum Dynamic Deflections December, 1938 and July, 1939 and Static Deflections July, 1939

Joint Series No.	Dynamic A--B 30 Miles Per Hour Dec. 1938	July 1939	Diff.	A--B 15 Miles Per Hour Dec. 1938	July 1939	Diff.	D--E 30 Miles Per Hour Dec. 1938	July 1939	Diff.	D--E 15 Miles Per Hour Dec. 1938	July 1939	Diff.	Static A--B July 1939	Static D--E July 1939
1	.008"	.032"	.024"	.008"	.034"	.026"	.006"	.028"	.022"	.008"	.030"	.022"	.045"	.034"
2	.012"	.041"	.029"	.014"	.043"	.029"	.013"	.035"	.022"	.012"	.038"	.026"	.048"	.042"
3	.009"	.036"	.027"	.010"	.038"	.028"	.010"	.032"	.022"	.011"	.037"	.026"	.044"	.037"
4	.012"	.048"	.036"	.014"	.048"	.034"	.011"	.044"	.033"	.011"	.046"	.035"	.066"	.055"
5	.006"	.015"	.009"	.009"	.019"	.010"	.008"	.014"	.006"	.008"	.014"	.006"	.022"	.014"
6	.009"	.045"	.036"	.008"	.050"	.042"	.008"	.040"	.032"	.010"	.042"	.032"	.064"	.050"
7	.010"	.033"	.023"	.010"	.040"	.030"	.008"	.030"	.022"	.008"	.033"	.025"	.048"	.037"
8	.008"	.033"	.025"	.006"	.038"	.032"	.006"	.030"	.024"	.007"	.032"	.025"	.043"	.036"
9	.006"	.035"	.029"	.008"	.041"	.033"	.008"	.035"	.027"	.008"	.038"	.030"	.047"	.041"
10	.005"	.028"	.023"	.006"	.028"	.022"	.008"	.026"	.018"	.009"	.029"	.020"	.039"	.033"
11	.004"	.025"	.021"	.006"	.024"	.018"	.006"	.019"	.013"	.005"	.021"	.016"	.032"	.022"

TABLE 5

Comparison of Average Maximum Dynamic Differential Deflections
December, 1938 and July, 1939 and Static Deflections July, 1939

Joint Series No.	Dynamic												Static	
	A--B						D--E						A-B	D-E
	30 Miles Per Hour			15 Miles Per Hour			30 Miles Per Hour			15 Miles Per Hour				
	Dec. 1938	July 1939	Diff.	Dec. 1938	July 1939	Diff.	Dec. 1938	July 1939	Diff.	Dec. 1938	July 1939	Diff.	July 1939	July 1939
1	.005"	.008"	.003"	.004"	.008"	.004"	.005"	.008"	.003"	.005"	.009"	.004"	.012"	.005"
2	.008"	.018"	.010"	.009"	.018"	.009"	.007"	.012"	.005"	.009"	.012"	.003"	.018"	.014"
3	.005"	.012"	.007"	.006"	.011"	.005"	.007"	.011"	.004"	.006"	.011"	.005"	.016"	.010"
4	.010"	.048"	.042"	.013"	.047"	.034"	.009"	.046"	.037"	.011"	.047"	.036"	.066"	.053"
5	.001"	.002"	.001"	.001"	.001"	.000"	.002"	.001"	-.001"	.002"	.002"	.000"	.002"	.003"
6	.006"	.019"	.013"	.006"	.019"	.013"	.006"	.015"	.009"	.006"	.016"	.010"	.023"	.010"
7	.003"	.005"	.002"	.004"	.004"	.000"	.003"	.004"	.001"	.003"	.003"	.000"	.006"	.004"
8	.004"	.006"	.002"	.003"	.005"	.002"	.003"	.003"	.000"	.002"	.003"	-.001"	.006"	.006"
9	.002"	.003"	.001"	.003"	.003"	.000"	.003"	.003"	.000"	.003"	.002"	-.001"	.004"	.004"
10	.003"	.004"	.001"	.003"	.004"	.001"	.004"	.004"	.000"	.003"	.005"	.002"	.006"	.007"
11	.001"	.002"	.001"	.001"	.002"	.001"	.001"	.001"	.000"	.001"	.001"	.000"	.002"	.002"

TABLE # 6

Comparison of Maximum Day and Night Dynamic Deflections at Several Selected Points, July, 1939

Joint No.		Time	30 Miles Per Hour Deflection D	30 MPH Deflection E	30 MPH Deflection F	30 MPH Differential DE	15 Miles Per Hour Deflection D	15 MPH Deflection E	15 MPH Deflection F	15 MPH Differential DE	Temperature °F Pavement Slab Top	Pavement Slab Cent.	Pavement Slab Btm.	Atmosphere
11-1-NE	Night	11:30 PM	.022"	.022"		.002"	.024"	.024"	.003"	.001"	98	103	106	81
		11:40 PM	.021"	.024"	.003"	.005"	.024"	.025"	.003"	.002"	98	104	105	76
		5:25 AM	.024"	.024"	.004"	.000"	.025"	.028"	.003"	.003"	84	86	89	67
		Avg.	.022"	.023"	.004"	.002"	.024"	.026"	.003"	.002"	93	98	100	75
	Day	2:55 PM	.003"	.003"	.003"	.000"	.004"	.004"	.003"	.000"	117	108	101	99
		9:50 AM	.006"	.006"	.003"	.000"	.007"	.007"	.003"	.000"	98	94	92	87
		Avg.	.004"	.004"	.003"	.000"	.006"	.006"	.003"	.000"	108	101	96	93
1-2-S	Night	2:00 AM	.034"	.031"		.007"	.036"	.032"		.007"	93	95	93	76
		12:10 AM	.030"	.028"	.002"	.006"	.032"	.032"	.002"	.006"	96	102	103	70
		6:00 AM	.030"	.032"	.004"	.007"	.034"	.034"	.003"	.008"	84	86	89	69
		Avg.	.031"	.030"	.003"	.007"	.034"	.033"	.002"	.007"	91	94	95	72
	Day	3:15 PM	.005"	.004"	.003"	.002"	.005"	.003"	.003"	.002"	117	108	101	99
		10:10 AM	.008"	.005"	.002"	.005"	.008"	.005"	.002"	.004"	98	94	92	87
		Avg.	.006"	.004"	.002"	.004"	.006"	.004"	.002"	.003"	108	101	96	93
2-2-S	Night	3:20 AM	.039"	.033"		.015"					89	93	93	73
		12:50 AM	.035"	.033"	.004"	.011"	.036"	.035"	.004"	.008"	94	100	101	69
		Avg.	.037"	.033"	.004"	.013"	.036"	.035"	.004"	.008"	91	96	97	71
	Day	2:45 PM	.009"	.009"	.003"	.005"	.009"	.010"	.002"	.006"	116	115	107	99
		10:45 AM	.011"	.010"	.003"	.007"	.012"	.010"	.002"	.007"	99	96	103	87
		Avg.	.010"	.010"	.003"	.006"	.010"	.010"	.002"	.006"	108	106	105	93
4-2-S	Night	4:45 AM	.045"	.054"		.050"	.050"	.057"		.051"	84	90	92	70
		1:50 AM	.044"	.054"	.004"	.052"	.046"	.052"	.004"	.048"	90	94	98	67
		Avg.	.044"	.054"	.004"	.051"	.048"	.054"	.004"	.050"	87	92	95	69
	Day	4:10 PM	.008"	.007"	.003"	.004"	.008"	.007"	.004"	.005"	116	115	107	99
		11:05 AM	.011"	.009"	.003"	.007"	.007"	.012"	.003"	.009"	101	100	95	88
		Avg.	.010"	.008"	.003"	.006"	.008"	.010"	.004"	.007"	108	108	101	94

TABLE # 7

Joint No.	Time	Static Loading: Maximum Deflection A	B	D	E	C	F	Maximum Differential AB	DE	Base Readings Taken December, 1938: Change in Elevation Since December, 1938 A	B	D	E	C	F	Change in Joint Opening AB	DE	Temperature Degrees F. Top	Center	Bottom
1-1-I 1-2-S 1-3-S	10:30 PM 2:30 AM 12:30 AM 6:00 AM 3:30 PM 10:20 AM 4:45 AM	.047" .044"	.044"	.035" .036" .038" .006" .009" .033"	.033" .036" .038" .006" .008" .035"		.002" .002" .002" .002"	.012"	.003" .006" .008" .002" .004" .007"	.145" .180" .180"	.175" .165" .170"	.075" .130" .130" .130" .085" .085" .090"	.070" .130" .130" .130" .085" .090" .105"		* .000" .005" .000"	-.075" -.150" -.100"	-.085" -.160" -.165" -.160" -.255" -.180" -.095"	100 93 96 84 117 98 92	109 95 102 86 108 94 97	112 93 103 89 101 92 97
2-1-A 2-2-S 2-3-S	1:30 AM 4:30 AM 1:25 AM 3:50 PM 10:50 AM 5:00 AM	.047" .052"	.044" .054"	.048" .040" .009" .012" .042"	.040" .041" .010" .012" .040"		.002" .003" .002"	.020" .016"	.019" .010" .005" .007" .010"	.160" .150" .115"	.165" .135" .135"	.105" .055" .050" .000" .000" .070"	.115" .060" .055" .005" .005" .065"	.145"	* .009" .005"	-.140" -.150" -.085"	-.145" -.145" -.160" -.245" -.190" -.100"	100 89 94 116 99 91	109 93 100 115 96 97	112 93 101 107 93 97
3-1-I 3-2-S 3-3-S	2:00 AM 5:00 AM 5:30 AM	.034" .055"	.037" .052"	.029" .042"	.032" .045"			.015" .018"	.010" .010"	.195" .365" .160"	.190" .375" .165"	.120" .280" .105"	.125" .300" .110"	.055"		-.080" -.100" -.085"	-.085" -.090" -.095"	98 86 90	107 91 96	110 92 98
4-1-N 4-2-S 4-3-S	2:30 AM 5:00 AM 2:00 AM 4:20 PM 11:15 AM 6:30 AM 12:30 AM	.062" .067" .056"	.074" .052" .070"	.036" .054" .053" .008" .012" .054" .045"	.041" .059" .062" .008" .012" .057" .052"		.003" .003"	.069" .063" .066"	.033" .052" .053" .004" .009" .054" .054"	.135" .155" .080" .075"	.180" .175" .155" .145"	.090" .090" .090" .035" .035" .060" .055"	.115" .125" .110" .065" .060" .075" .060"	.150"	* .010" .010"	-.130" -.140" -.115" -.130"	-.160" -.135" -.145" -.235" -.185" -.095" -.110"	88 84 90 116 101 90 87	94 90 94 115 100 96 92	94 92 98 107 95 98 94
5-1-NJ 5-2-NJ 5-3-NJ	3:30 AM 6:00 AM 4:45 PM 11:35 AM 12:30 AM 12:15 AM	.018" .024" .021"	.021" .025" .021"	.014" .006" .007" .014" .011"	.016" .008" .008" .017" .013"		.003"	.003" .002" .000"	.002" .002" .003" .003" .003"	.205" .110" .155" .155"	.205" .095" .165" .160"	.170" .085" .075" .070" .120" .130"	.175" .080" .065" .060" .125" .125"	.175"	* -.010	-.085" -.120" -.090" -.105"	-.070" -.105" -.185" -.155" -.090" -.105"	96 82 112 103 87 88	100 90 112 102 92 94	104 92 109 97 94 94
6-1-A 6-2-S 6-3-S	4:00 AM 6:30 AM 2:30 AM	.059" .068"	.066" .063"	.046" .047"	.054" .052"			.019" .027"	.005" .016"	.180" .165" .115"	.200" .185" .120"	.155" .135" .070"	.180" .140" .080"			-.115" -.090" -.090"	-.120" -.095" -.090"	91 80 88	96 88 93	99 92 94
7-1-N 7-2-S 7-3-S	5:30 AM 12:10 AM 4:30 AM	.040" .056"	.040" .052"	.031" .041"	.032" .043"			.003" .008"	.003" .002"	.230" .190" .160"	.245" .170" .160"	.155" .145" .090"	.180" .135" .095"	.245"		-.065" -.115" -.085"	-.085" -.120" -.070"	88 102 88	93 106 91	96 111 92
8-1-A 8-2-S 8-3-S	6:00 AM 12:15 AM 4:45 AM	.037" .049"	.037" .049"	.029" .038"	.034" .038"			.006" .007"	.006" .005"	.300" .130" .190"	.290" .120" .160"	.200" .080" .105"	.195" .075" .095"	.135"		-.095" -.145" -.130"	-.100" -.145" -.115"	86 100 88	91 104 90	94 108 91
9-1-T 9-2-T 9-3-T	6:30 AM 1:00 AM 5:00 AM 1:00 AM	.043" .051" .044"	.043" .053" .047"	.035" .043"	.038" .047"			.003" .005" .005"	.004" .004"	.205" .220" .230" .220"	.205" .165" .225" .220"	.150" .190" .150" .140"	.150" .195" .160" .150"	.110"		-.090" -.080" -.115" -.145"	-.070" -.085" -.105" -.140"	82 99 88 87	85 103 90 92	88 106 91 96
10-1-C 10-2-C 10-3-C	11:30 PM 1:30 AM 5:15 AM	.035" .039"	.034" .038"	.033" .034"	.030" .036"			.008" .005"	.007" .007"	.300" .145"	.240" .280" .140"	.170" .205" .075"	.175" .195" .090"	.190"		-.105" -.015"	-.180" -.115" -.015"	100 98 88	105 102 90	108 103 91
11-1-NE 11-2-NE 11-3-NE	11:45 PM 11:45 PM 5:30 AM 3:10 PM 10:00 AM 3:00 AM 6:00 AM	.025" .037"	.027" .038"	.026" .029" .003" .008" .018" .027"	.028" .031" .005" .009" .016" .027"		.002" .004"	.003" .001"	.002" .002" .002" .001" .002" .001"	.185" .110" .085"	.180" .115" .105"	.135" .135" .140" .095" .110" .065" .045"	.135" .140" .140" .110" .110" .075" .060"	.115"	* .010 .010	-.050" -.070" -.065"	-.060" -.065" -.060" -.100" -.085" -.070" -.070"	98 98 84 117 98 97 88	103 104 86 108 94 101 90	106 105 89 101 92 101 91
C-7-1-7C C-7-2-7C C-7-4-5C C-7-5-3C C-7-6-3C	11:00 AM 4:00 AM 12:30 AM 1:00 AM 5:00 AM	.026" .028" .020" .021" .018"	.027" .027" .023" .023" .018"	.018" .021" .014" .016" .015"	.019" .022" .015" .016" .016"	.009" .006"		.001" .001" .005" .002" .002"	.001" .002" .002" .001" .002"	.110" .230" .235" .275" .285"	.110" .225" .245" .280" .285"	.060" .135" .155" .195" .210"	.055" .140" .155" .195" .205"	.045" .135" .145" .135" .130"		+.040" +.030" +.045" +.045"	+.035" +.030" +.050" +.050"	90 88 88 86 86	96 92 94 93 89	97 96 96 96 93
Station	Time	Standard expansion joints—60' intervals—Standard weakened plane—2 dowels—15' intervals																		
474+50C 475+10C	5:15 AM 4:45 AM			.030" .029"	.025" .025"				.010" .009"				.020"				+.100" +.100"	79 81	85 87	86 88
		Standard expansion joints—60' intervals—Standard weakened plane—no dowels—15' intervals																		
480+50C 481+10C	4:15 AM 3:50 AM			.031" .027"	.037" .031"				.015" .006"				.005" .030"				+.120" +.095"	80 82	88 89	90 91
		Standard expansion joints---- 120' intervals---- Standard weakened plane---- now dowels---- 15' intervals																		
485+00C 485+60E 486+20C	3:25 AM 5:00 AM 5:00 AM	.035"	.037"	.031" .028" .030"	.035" .031" .035"			.006"	.009" .008" .004"				.030" .050" .025"				+.116" -.280" +.064"	83 78 88	90 83 95	92 83 97
		3/4" thickened edge expansion joints—9 dowels—210' intervals—Std. weakened plane—no dowels—15' intervals																		
489+05C 490+10E 491+15C	5:30 AM 6:15 AM 2:45 AM	.028"	.031"	.036" .025" .024"	.040" .024" .025"			.007"	.011" .004" .004"				.025" .015" .005"				+.100" -.360" +.025"	76 76 90	80 80 96	81 81 96
		3/4" thickened edge expansion joints—9 dowels—300' intervals—Std. weakened plane—no dowels—15' intervals																		
503+50C 505+00E 506+50C	1:10 AM 12:30 AM 11:25 PM	.020"	.021"	.022" .016" .013	.025" .019" .019"			.008"	.003" .006" .006"				.085" .110" .025"				+.060" -.600" +.055"	92 94 95	98 100 101	100 101 102
		3/4" thickened edge expansion joints—9 dowels—405' intervals—Std. weakened plane—no dowels—15' intervals																		
512+00C 513+05C 513+95C	5:30 AM 5:05 AM 4:30 AM			.021" .014" .017"	.024" .017" .021"				.004" .003" .004"				.015" .015" .020"				-.460" +.040" +.060"	84 85 87	86 88 91	89 91 94
		3/4" thickened edge expansion joints—9 dowels—510' intervals—Std. weakened plane—no dowels—15' intervals																		
528+60C 529+35C 530+55C	4:00 AM 2:00 AM 3:00 AM			.015" .014" .018"	.019" .018" .029"				.004" .004" .011"				.065" .105" .065"				+.040" +.065" +.050"	88 87 86	92 92 93	96 96 96

* Base readings taken on point "F".

TABLE # 8

DEFLECTIONS ALONG LONGITUDINAL JOINT UNDER REAR AXLE LOAD OF 14,840#

Station No.	DYNAMIC DEFLECTIONS								STATIC DEFLECTIONS			
	Maximum				Differential				Maximum		Differential	
	30 M.P.H.		15 M.P.H.		30 M.P.H.		15 M.P.H.					
	G	H	G	H	G	H	G	H	G	H	G	H
627+50 C	.004"	.002"	.004"	.003"	.002"	.000"	.002"	.000"	.004"	.003"	.001"	.001"
628+10 C	.004"	.002"	.005"	.002"	.002"	.001"	.002"	.001"	.004"	.003"	.002"	.002"
628+90 E	.008"	.003"	.009"	.004"	.005"	.002"	.005"	.002"	.009"	.004"	.007"	.002"
629+50 E	.006"	.003"	.005"	.002"	.004"	.000"			.006"	.002"	.003"	.000"

E--Expansion Joint
C--Weakened Plane
Y--Center of Pavement Slab

TABLE # 9 X-Mer-4-A

CHANGE IN OPENING ACROSS JOINTS

60' Expansion Joint Intervals
Concrete Placed December 8, 1938
Base Readings Taken December 9, 1938

Station No.	June 26 1939 8:00 A.M.
480+20 E	-.230"
35 C	.065"
50 C	.120"
65 C	.090"
80 E	-.270"

120' Expansion Joint Intervals
Concrete Placed December 8, 1938
Base Readings Taken December 9, 1938

Station No.	June 26 1939 8:30 A.M.	July 28 1939 5:00 P.M.
484+40 E	-.180"	-.380"
55 C	.055"	.060"
70 C	.065"	.065"
85 C	.050"	.050"
485+00 C	.095"	.110"
15 C	.060"	.065"
30 C	.060"	.070"
45 C	.060"	.070"
60 E	-.280"	-.550"

(More)

210' Expansion Joint Intervals
Concrete Placed December 8, 1938
Base Readings Taken December 9, 1938

Station No.	June 26 1939 9:00 A.M.	July 27 1939 5:30 A.M.
490+10 E	-.350"	-.570"
25 C	.050"	.180"
40 C	.055"	.100"
55 C	.055"	.085"
70 C	.055"	.085"
85 C	.060"	.085"
491+00 C	.090"	.115"
15 C	.055"	.075"
30 C	.120"	.150"
45 C	.060"	.095"
60 C	.075"	.113"
75 C	.065"	.105"
90 C	.060"	.095"
492+05 C	.055"	.105"
20 E	-.405"	-.625"

(More)

TABLE # 9 (Con't) X-Mer-4-A

300' Expansion Joint Intervals
Concrete Placed December 6, 1938
Base Readings Taken December 7, 1938

Station No.	June 26 1939 9:30 A.M.	July 26 1939 6:00 A.M.	July 27 1939 5:00 P.M.
505+00 E	-.380"	-.760"	-.880"
15 C	.010"	.075"	.025"
30 C	.045"	.080"	.055"
45 C	.040"	.180"	.150"
60 C	.045"	.085"	.060"
75 C	.090"	.135"	.095"
90 C	.035"	.065"	.040"
506+05 C	.045"	.075"	.045"
20 C	.045"	.070"	.050"
35 C	.170"	.195"	.155"
50 C	.035"	.045"	.040"
65 C	.035"	.065"	.040"
80 C	.040"	.065"	.045"
95 C	.050"	.080"	.055"
507+10 C	.040"	.075"	.050"
25 C	.050"	.085"	.060"
40 C	.095"	.140"	.100"
55 C	.045"	.095"	.060"
70 C	.055"	.120"	.065"
85 C	.040"	.115"	.060"
508+00 E	-.415"	-.895"	-.910"

TABLE # 10 X-Mer-4-A

SUBGRADE MOISTURE % DRY WEIGHT

Station No.		Depth 0--8" Nov. 1938	Depth 0--8" June 1939	Depth 14"--28" Nov. 1938	Depth 14"--28" June 1939
474+42.5	Y		14		11
474+50	C	14	14	11	12
475+02.5	Y		13		12
475+10	C	15	14	12	13
480+42.5	Y		15		11
480+50	C	14	14	11	10
481+02.5	Y		15		11
481+10	C	15	14	10	12
484+92.5	Y		13		10
485+00	C	14	12	9	9
485+52.5	Y		12		10
485+60	E	13	11	10	11
486+20	C	13	12	11	12
488+97.5	Y		11		13
489+05	C	12	12	10	10
490+02.5	Y		10		13
490+10	E	14	12	12	15
491+07.5	Y		12		11
491+15	C	13	12	11	13
503+50	C	11	13	11	12
505+00	E	11	13	12	11
506+42.5	Y		12		12
506+50	C	13	12	12	12
511+90	Y		13		11
512+00	E	12	13	11	16
513+05	C	12	12	9	12
513+95	C	13	12	12	13
528+60	C	11	13	13	13
529+35	C	14	15	11	13
530+55	C	13	14	14	15
627+52		11		10	
628+12		12		9	
629+42		12		11	
629+48		12		11	
633+30	Y		10		13
638+10	Y		7		12
642+90	Y		10		15
647+70	Y		8		12
651+90	Y		9		16
657+[illegible]0	Y		8		14

E--Expansion Joint
C--Weakened Plane
Y--Center of Pavement Slab

(More)

SUBGRADE MOISTURE % OF DRY WEIGHT

Station No.	Depth 0--8"		Depth 14"--26"	
	Nov. 1938	June 1939	Nov. 1938	June 1939
667+70 Y		8		9
668+20 E	13	12	14	16
668+70 Y		11		14
668+80 E	10	11	13	14
669+30 Y		9		14
669+40 E	10	11	11	15
669+90 Y		10		13
670+00 E	11	10	16	11
670+50 Y		10		12
670+60 E	11	11	16	14
671+10 Y		11		17
671+20 E	11	11	15	16
671+70 Y		10		17
671+80 E	11	11	20	17
672+30 Y		11		18
672+40 E	12	11	19	20
672+90 Y		9		14
673+00 E	11	11	14	14
673+50 Y		10		11
673+60 E	11	11	13	13
674+10 Y		10		14
674+20 E	10	9	14	13
674+70 Y		10		15
674+80 E	11	11	16	14
675+30 Y		10		17
675+40 E	12	11	10	11
675+90 Y		11		12
676+00 E	12	12	9	13
676+50 Y		11		14
676+60 E	12	11	11	13
677+10 Y		9		13
677+20 E	12	10	10	12
677+70 Y		10		17
677+80 E	12	11	21	19
678+30 Y		10		16
678+40 E	13	12	14	14
678+90 Y		10		17
679+00 E	12	12	17	19
679+50 Y		10		13
679+60 E	11	11	17	18
680+10 Y		11		17
680+20 E	11	11	15	15
680+70 Y		10		9
680+80 E	11	10	7	12

E--Expansion Joint
C--Weakened Plane
Y--Center of Pavement Slab

(More)

TABLE 10 (Con't.) X-Mer-4-A

SUBGRADE MOISTURE % OF DRY WEIGHT

Station No.		Depth 0--8" Nov. 1938	Depth 0--8" June 1939	Depth 14"--26" Nov. 1938	Depth 14"--26" June 1939
681+30	Y		9		12
681+40	E	11	9	13	14
681+50	Y		11		11
681+60	C		10		12
681+70	Y		9		10
681+80	C	11	10	12	14
681+90	Y		9		11
682+00	E	10	10	12	16
682+10	Y		9		9
682+20	C	11	10	15	15
682+30	Y		9		11
682+40	C		11		16
682+50	Y		10		14
682+60	E	12	10	12	11
682+70	Y		10		11
682+80	C		10		11
682+90	Y		10		12
683+00	C		10		12
683+10	Y		12		14
683+20	E	13	12	11	11
683+30	Y		12		15
683+40	C		11		18
683+50	Y		10		15
683+60	C		11		16
683+70	Y		9		15
683+80	E	12	10	19	16
683+90	Y		10		15
684+00	C		9		12
684+10	Y		10		15
684+20	C		9		15
684+30	Y		10		14
684+40	E	11	10	18	19
684+50	Y		10		11
684+60	C		10		13
684+70	Y		10		13
684+80	C	10	10	15	11
684+90	Y		9		20
685+00	E	14	11	23	11
685+10	Y		9		12
685+20	C		10		9
685+ 30	Y		10		8
685+40	C	12	12	9	15
685+50	Y		11		7
685+60	C	12	13	9	13
685+70	Y		12		9

(More)

TABLE 10 (Con't.) X-Mer-4-A

Station No.		SUBGRADE MOISTURE % OF DRY WEIGHT Depth 0--8" Nov. 1938	Depth 0--8" June 1939	Depth 14"--26" Nov. 1938	Depth 14"--26" June 1939
685+80	C	11	11	7	12
~~685+90~~	Y		12		9
686+00	C		13		14
686+10	Y		12		13
686+20	E	12	11	16	14
686+30	Y		10		12
686+40	C		11		12
686+50	Y		11		13
686+60	C		10		15
686+70	Y		10		13
686+80	E	11	11	15	13
686+90	Y		13		14
687+00	C		13		17
687+10	Y		12		16
687+20	C		12		15
687+30	Y		10		14
687+40	E	11	10	13	14
687+50	Y		12		13
687+60	C		10		13
Average		12%	11%	13%	13%

E--Expansion Joint
C--Weakened Plane
Y--Center of Pavement Slab

TABLE II

SOIL TESTS ON SUBGRADE

Constructed of Selected Imported borrow 0-1' Depth

Samples taken from test and observational sections after subgrade was constructed

Station No.	Grading Analysis % Clay	% Silt	% Sand	Liquid Limit	Plasticity Index	Bearing* Value %	Swell %
635+00	10	26	64			79	0.8
638+00	13	27	60			53	0.1
642+00	9	23	68			36	0.2
645+00	15	27	58			42	1.6
649+00	14	25	61			50	1.2
654+00	17	29	54			70	0.6
668+20	14	29	57	20	6	60	1.0
672+40	13	26	61	21	7	19	2.6
676+00	15	28	57	21	7	33	2.2
Avg.	13	27	60	21	7	49	1.1

* Bearing value at 0.1" penetration for the compacted and soaked specimens.

TABLE 12

SOIL TESTS ON SUBSOIL

1 to 2 or 3 feet below bottom of pavement

Station No.	Grading Analysis % Clay	% Silt	% Sand	Liquid Limit	Plasticity Index	Bearing* Value	Swell %
613+15	--	--	--			4	5.3
624+00	22	34	44			4	6.6
625+00	--	--	--			3	5.6
628+50	37	47	16			2	7.0
635+50	46	30	24			2	7.2
648+50	32	37	31			4	5.7
650+00	--	--	--			5	5.3
668+20	17	32	51	22	7	8	4.8
670+00	22	33	45	24	7	6	6.8
672+40	22	38	40	23	8	7	7.1
673+00	20	35	45	23	8	9	5.0
673+60	23	37	40	22	7	8	5.2
674+80	22	36	42	24	8	5	6.7
675+00	--	--	--	--	-	4	6.1
676+00	26	43	31	25	10	7	4.2
Avg.	26	37	37	23	8	5	5.9

* Bearing value at 0.1" penetration for the compacted and soaked specimen.

TABLE 13

RELATIVE COMPACTION OF SUBGRADE MATERIALS

Consisting of Selected Imported Borrow 0-1' Depth

Station No.	Dry Wt. Per Cu. Ft. In Place	% Moist. In Place	Relative * Compaction
628+00	128.1	11	100
630+00	128.2	13	100
632+00	119.6	11	94
634+00	122.6	11	96
636+00	119.4	12	94
638+00	111.9	11	88
640+00	119.4	13	94
642+00	115.7	13	91
644+00	108.6	13	85
646+00	124.0	11	97
648+00	127.4	12	100
650+00	124.4	10	98
652+00	134.6	11	105
654+00	133.5	11	105
656+00	126.7	10	99
658+00	121.2	11	95
660+00	127.3	10	100
662+00	122.1	10	96
664+00	121.5	10	95
666+00	127.1	13	100
667+60	123.8	12	97
668+20	123.6	11	97
668+80	126.6	10	99
669+40	125.3	9	98
670+00	130.3	11	102
670+60	123.1	10	97
671+20	124.4	10	97
671+80	131.9	9	103

(More)

TABLE 13 (Con't.)

Station No.	Dry Wt. Per Cu. Ft. In Place	% Moist. In Place	Relative* Compaction
672+40	134.4	11	105
673+00	125.3	11	98
673+60	126.0	10	99
674+20	130.3	11	102
674+80	125.0	10	98
675+40	122.1	11	96
676+00	123.7	12	97
676+60	123.0	11	97
677+20	127.2	11	100
677+80	128.6	11	101
678+40	126.1	13	99
679+00	124.8	10	98
679+60	133.6	10	105
680+20	126.7	12	99
680+80	123.5	11	97
681+40	117.8	9	92
682+00	121.9	9	96
682+60	121.6	10	95
683+20	123.9	13	97
683+80	129.0	11	101
684+40	128.2	10	100
685+00	118.8	10	93
685+60	123.9	9	97
686+20	128.3	11	101
686+80	130.1	11	102
687+40	129.6	10	102
Avg.	124.9	11	98

* Relative compaction determined in accordance with California compaction method, using an average dry weight per cubic foot compacted of 127.5lbs. The samples tested showed a compacted weight (dry) ranging between 126 and 129 lbs. per cubic foot.

TABLE 14

RELATIVE COMPACTION OF SUBSOIL MATERIALS

1 to 2 feet below bottom of pavement

Station No.	Dry Wt. Per Cu. Ft. In Place	% Moist. In Place	Relative ** Compaction
628+00	113.4	11	93
630+00	109.9	12	91
632+00	112.2	11	93
634+00	118.2	13	97
636+00	105.2	14	87
638+00	112.4	12	93
640+00	108.5	11	89
642+00	112.5	15	93
644+00	135.6	14	108*
646+00	114.0	12	94
648+00	122.5	13	98*
650+00	110.6	11	91
652+00	107.0	12	88
654+00	107.8	14	89
656+00	109.4	9	90
658+00	109.4	12	90
660+00	110.5	11	91
662+00	119.2	11	95*
664+00	107.7	13	99
666+00	116.7	12	96
667+60	123.0	13	98*
668+20	114.0	12	94
668+80	112.8	12	93
669+40	117.6	13	97
670+00	120.5	13	96*
670+60	124.0	11	99*
671+20	121.3	11	96*
671+80	111.5	17	92
672+40	116.1	11	96
673+00	111.2	14	92
673+60	116.4	11	96
674+80	119.4	14	95*

(More)

TABLE 14 (Con't.)

Station No.	Dry Wt. Per Cu. Ft. In Place	% Moist. In Place	Relative** Compaction
674+80	123.2	15	98*
675+40	126.4	13	101*
676+00	124.6	10	99*
676+60	117.6	9	97
677+20	121.4	12	97*
677+80	113.1	13	95
678+40	122.9	14	98*
679+00	110.9	12	91
679+60	123.4	12	98*
680+20	120.4	14	96*
680+80	126.2	13	100
681+40	106.1	9	88
682+00	110.4	12	91
682+60	107.6	13	89
683+20	108.1	12	89
683+80	112.1	9	93
684+40	111.3	10	92
685+00	114.6	10	95
685+60	121.9	13	97*
686+20	126.8	12	101*
686+80	118.7	10	98
687+40	110.0	12	91
Ave.	116	12	94

** Relative compaction determined in accordance with California Standard Field Compaction Method. Except as noted below, an average dry weight per cubic foot compacted of 121.5 lbs. was used in computing the relative compaction. The samples of this class of material showed a weight (dry) ranging between 118 and 123 lbs. per cubic foot.

* These samples contained somewhat more sand than the samples referred to above (**). The material showed a dry weight per cubic foot compacted, ranging between 123 and 127 lbs. and averaging 125.5 lbs. per cubic foot, which was used in computing the relative compaction of these samples.